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VOLUME 16 NOVEMBER 1937 NUMBER 11

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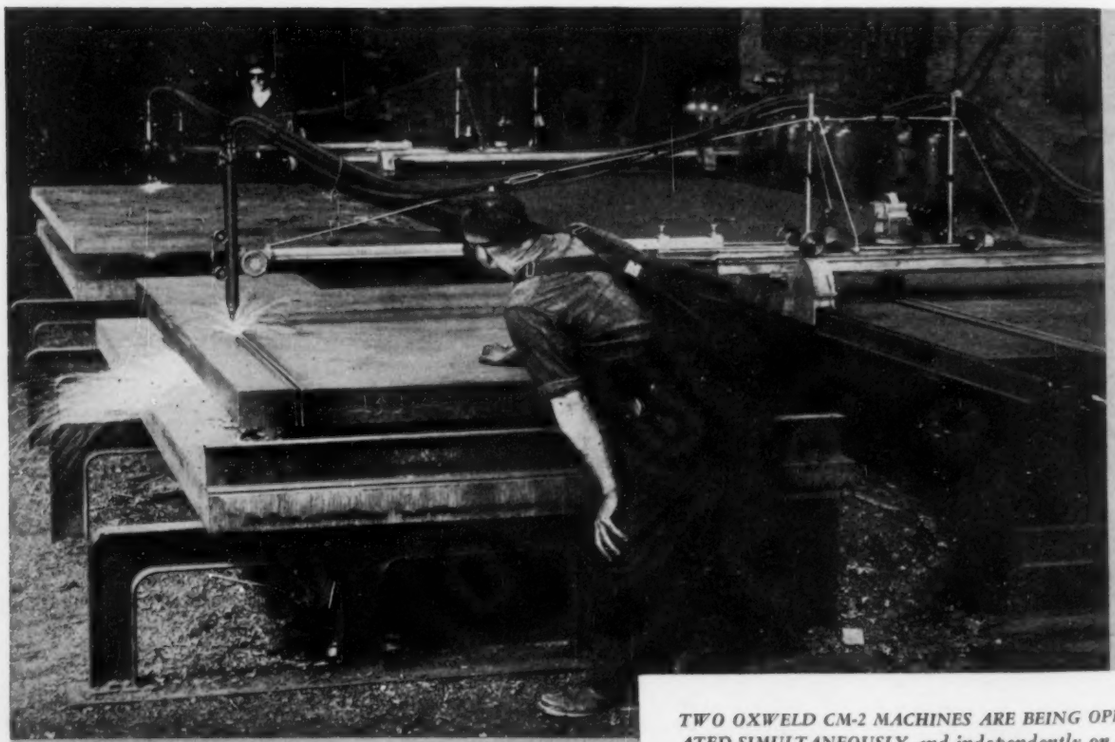

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# Growth and Spread of Arc Welding in Canada*

By A. S. WALL, M.E.I.C.†

**Summary.**—*Outlines the development of arc welding in Canadian shops with notes on electrodes, fabrication procedure, stress relief, X-ray examination, and the training of operators. A detailed analysis of various types of joints is given.*

THE Semicentennial Anniversary of The Engineering Institute of Canada, founded in 1887 as the Canadian Society of Civil Engineers, is taking place just about fifty years after the discovery of metallic electrode arc welding.

The process of arc welding, although discovered so many years ago, remained comparatively unknown until the urgent requirements of a world at war unveiled the merits of the tool and placed it in the foreground as a very convenient way to make repairs in place, saving valuable time by avoiding dismantling and replacement. At that time, and for several years later, the idea that a metallic electrode arc welding set was essentially a repair kit persisted and it was valued more or less in proportion to its user's success in application.

* Paper presented at the Semicentennial Meeting of The Engineering Institute of Canada in June 1937, in Montreal and printed in the September 1937 issue of *The Engineering Journal*.

† Dominion Bridge Company Limited, Montreal.

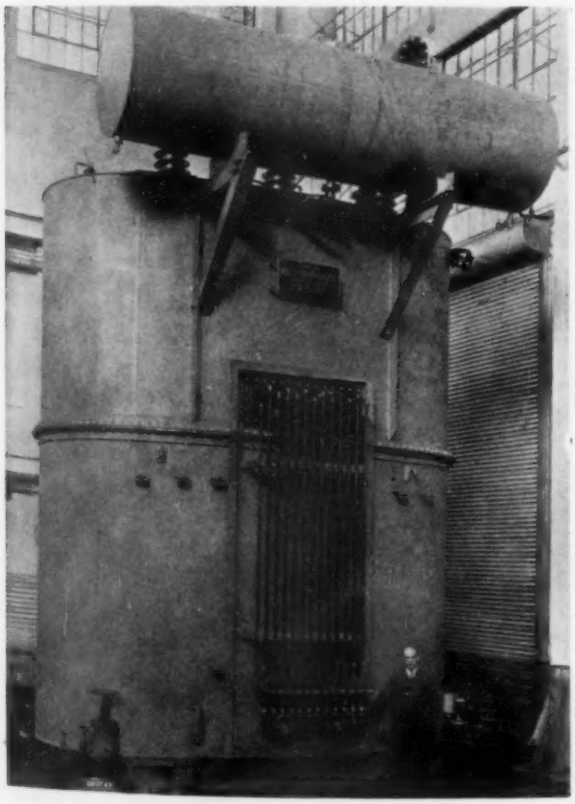


Fig. 1—Arc-Welded Transformer Tank, Canadian Westinghouse

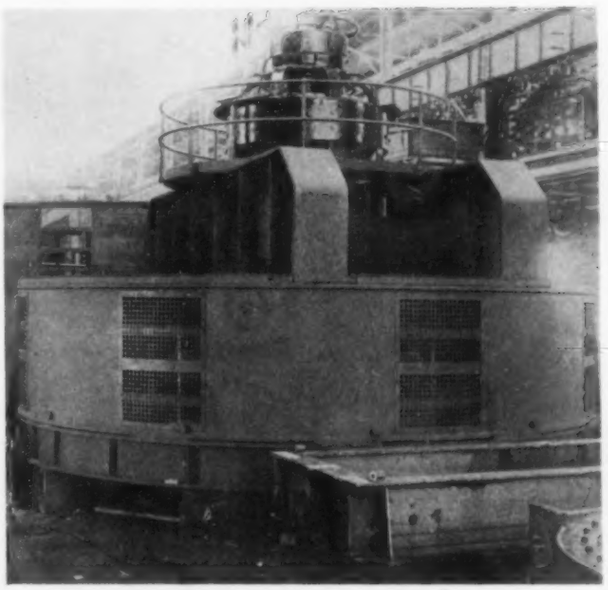


Fig. 2—Arc-Welded A.C. Generator, Canadian General Electric

Gradually however, with succeeding years, engineers have learned that arc welding is not only a first class repair tool but that it may be used advantageously for permanently joining connecting parts of major structures.

In its evolution it has grown from a handy tool for the repair of defective steel castings to the means for connecting rolled steel parts to replace castings. It has developed from an easy way of repairing boiler tube sheets to a method by which the best quality of important pressure vessels are constructed. From its early use as a convenient way to plug misplaced holes it has risen in dignity until it is now playing a major part in the fabrication and erection of steel bridges and buildings. Its valuable features have made possible the development of original types of design to accomplish increased economy of material and amazing improvement in appearance.

The growth and spread of arc-welded construction in the last few years have been almost sensational although, as previously stated, it was considered for so many years only as a superior method of repair. As a matter of fact it is still regarded as no more than that by a few; but those who have had the opportunity to use it as a fabrication agent to any great extent are very appreciative of its structural worth.

A brief outline of the experiences of a few Canadian companies in their development of arc-welded farbrication will illustrate the strides made in the last ten years.

The Canadian Westinghouse Company began with a single welding set in 1923, using it largely for repair work. By 1925 it was necessary to find larger welding quarters, and again in 1927 the increased part of their product fabricated by the arc-welding process necessitated further expansion. In 1930 still greater enlargements were made. The floor space used for welded construction at that date

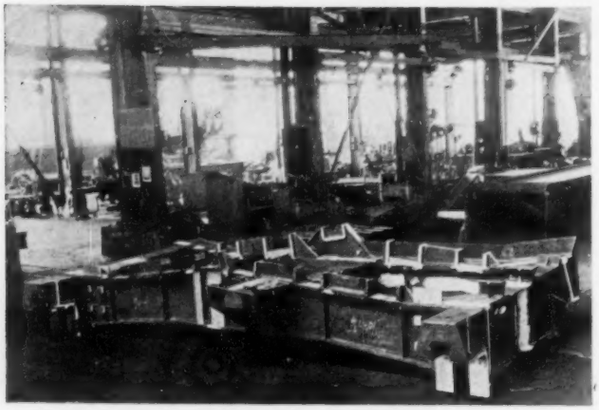


Fig. 3—Arc-Welded 60-Ton Crane Trolley Frame

had increased more than 600 per cent since 1923. During this period the number of welding units had increased from one to twenty-five, and there are probably thirty in use today.

Some idea of this company's new trend of design may be given by a description of the changes made in large A.C. generators.

Starting in 1926 with relatively unimportant parts such as welded stairs and platforms, every succeeding order saw more and more welded fabrication. The main exciter frames soon followed the platforms, with the lower bearing brackets as the next step. By 1930 the upper brackets and oil pots had become welded and in 1931–1932 the *last casting, the spider,* became a welded assembly. Since then these larger machines have been designed for entirely welded fabrication.

The company's developments in the transformer field advanced rapidly with the advent of welded tanks. Welded construction of endframes, bases and covers, etc., became standard practice just as quickly as the personnel could be trained and the shop equipped for it.

Their standard designs for synchronous motors from 100 to 3000 hp. are for welded fabrication and the spread of this type of construction for this company's wares grows daily.

The history of the growth and spread of arc-welded construction in the shops of the Canadian General Electric Company Limited is similar to that just described, but is none the less wonderful.

It is only about twelve years since this company's use of arc welding was almost exclusively as a means of repairing and making small parts, mostly for factory maintenance.

Since then rapid progress has been made, until today the parts of large A.C. generators such as stator frames, upper and lower bearing brackets, rotor spiders, bases, etc., are all of welded construction.

In fact the size of structures now made by this company by means of welding is limited only by shipping clearances.

Probably one of the greatest contributions made by welding to the construction industry is in connection with larger rotating parts. On large generators, cast rotor spiders are very heavy and expensive, requiring costly patterns, foundry uncertainties and expensive machinery. With the development of welded designs thinner parts are used, allowing a considerable saving in freight in addition to that made by the elimination of patterns, excess metal, machining, etc.

While the Canadian Locomotive Company Limited does not yet build standard types of steam locomotives of entirely welded construction yet the use of arc welding has increased greatly in their fabrication until now there are over one hundred and fifty different electric welding operations.

Thirteen welding units are necessary to meet the growing requirements of arc weld constructed work in this company.

At the Montreal Locomotive Works Limited, arc welding plays a similar part. Locomotive staybolt caps and sleeves, side sheets of fire-boxes and syphons are electrically welded.

The motive power departments of the railways use welding extensively.

In the Canadian National Railway shops most of the light plate work such as cabs, smoke deflectors, stoker conveyor troughs, tender tanks and swash plates, steps, etc., are fabricated by welding.

Riveted seams in their locomotive fire-boxes have been completely superseded by butt-welded joints and, in addition to this, the beads of back ends of all boiler flues are welded to the flue sheet.

Fractures in main frames or truck frames, bolsters or other steel castings are repaired by welding and bronze hub covers are welded to cast steel driving boxes.

Parts which are subject to excessive friction, and wear, such as conveyor screws, intermediate buffer blocks, chafing plates, etc., are built up to standard dimensions by arc welding as engines pass through the shops.

In the Angus shops of the Canadian Pacific Railway the growth of the application of arc welding has become so great that now it is difficult to comprehend how operations were carried out efficiently without its use in the past.

Whereas in the early days arc welding in this shop was confined to the output of one electric welding set, there are today 40 arc-welding sets in constant use in addition to gas equipment.

The early experiences of the Dominion Bridge Company Limited were like those of all the others. It first used arc welding commercially in the fabrication of light storage tanks. Other types of welded structures soon followed, notably embedded parts for hydraulic gates and parts formerly of cast steel. Arc-welded products of the Dominion Bridge Company Limited now include pressure vessels of all descriptions up to those of the highest code classifications requiring controlled oven stress relief and X-ray examination. Mechanical parts such as gear blanks, large gear boxes, lift bridge sheave drugs, crane trolleys, etc., are manufactured by this method. Welded steel structures for buildings of composite construction are a regular standard office and shop procedure; and bridges are fabricated by arc welding when that type of structure best suits all the requirements.

In 1917 the arc-welding equipment of this company consisted of two old box welders taking current directly from the power line and fluctuating with every variation in line load.

Today it has 45 machines in daily and often nightly use in its Lachine plant and each of its branches through-

Fig. 4—Arc-Welded Refinery Vessel 12 Ft. Diam. by 1⅜ In. Shell

out Canada has arc-welding facilities in proportion to its relative tonnage capacity.

The Lachine plant is equipped with two stress-relieving ovens, the larger one having an end opening of 14 ft. by 17 ft.

The plant also has a 300,000-volt X-ray machine capable of penetrating 3 inches of steel.

In 1930 only about 20 welding operators were needed but today in 1937 there are 60 operators in the Lachine plant with several more in training.

### Reasons for Accelerated Development

The greatly accelerated growth of arc-welded construction may be credited to improved welding machines, better electrodes, an increased knowledge of fabrication procedure, and better comprehension by engineers of the fundamental requirements necessary for its successful employment.

The builders of welding machines have supplied equipment to meet advancing requirements. Changes have been made chiefly to take care of the developments in types of electrodes.

Formerly 200 ampere machines with arc voltages of 25 were sufficient for the use of small bare electrodes. With the development of heavily coated electrodes, however, 300 and 400 ampere machines with arc voltages of 40 became necessary.

A.C. machines are being used much more than previously. Their chief advantage may be that they eliminate arc blow, but some authorities believe that they more consistently deposit a dense weld.

Electrodes have been so much improved that a choice may be had for any purpose. All grades from bare wire to the heavily coated electrodes used only for down-hand welding can be obtained. When other conditions are right these latter electrodes will produce joints equal in all respects to the parent metal., i.e., equal specific gravity, tension, shear and bending values, elongation, toughness and fatigue resistance. Some produce a molten metal surface of the meniscus type which helps greatly in obtaining pure weld metal by eliminating undercutting in grooves and thereby minimizing the necessity for chipping.

Electrodes may be divided into three main classifications.

One class of electrode is commonly known as "bare," but it always has a very light sull or lime coating. Although this coating is necessary, it exists only for arc stabilization.

Another class of electrode is one with a coating containing carbonaceous material which produces a gaseous atmosphere when burning. This electrode coating generates a gas which shields the arc from the atmosphere and leaves a slag which protects the molten metal. Electrodes of this type may be used for vertical fillet and vee welding as well as on the flat.

A third type of electrode is coated with a composition essentially of a mineral nature. Because of the relatively slower melting of the covering a cup forms at the tip of the electrode shielding the arc from the air and reducing heat losses. The slag which forms on the surface of the molten and hot metal in the groove acts as a blanket to insulate the weld while cooling. This type of electrode is essentially for welding in a groove in the flat position. When used by experts it will make very fine fillet welds on the flat, but this takes great skill.

### Fabrication Procedure

In the construction of arc-welded parts the members of the shop staff have had to develop procedures to keep residual stresses at a minimum, control distortion, prevent cracking while welding, etc., in addition to fabricating in an efficient and economical manner by the new method.

They have learned when and how to preheat to prevent cracking, to make separate sub-assemblies as far as possible before assembling to the larger structure, and to use only sufficient current for the required fusion.

When it is necessary to clamp an assembly firmly in order to prevent distortion while welding, the whole is preheated if possible and the welds are peened to eliminate or minimize residual stresses.

If conditions permit, however, instead of clamping they provide guides to allow pieces to change in allowable limited directions. When they can, they prefer to allow controlled freedom of movement in as many directions as possible.

In welding an assembly they start at the center and weld outward; and they have learned to make the heavier welds or those which will strain the most, such as butt welds, first and to finish with the lighter welds.

Where parts to be welded have several butt joints meeting at right angles at various points in the structure all the joints in one direction are welded first and then the remaining seams are welded from the center outward.

These and many other schemes have been developed by the shops to control the quality of the product.

The development and use of rotating and other equipment for turning parts in the shop to positions for down-hand welding in order to take advantage of large electrodes and high currents has done much to promote welded fabrication.

### Stress Relief

In important pressure vessels, and mechanical parts designed to operate under conditions of dynamic loading, it is now common practice to relieve stress at a temperature of about 1100 to 1200° F. This is done in large ovens capable of containing vessels or other structures about 12 ft. wide by 14 ft. high. The cross sectional capacity is governed by railway shipping clearances. By this operation residual stresses are reduced to a minimum and superior structures are produced.

### X-ray Examination

For some types of vessels such as power boiler drums, high pressure and high temperature oil refining vessels, etc., it is required to produce proof of the quality of the welding in the joints.

This is accomplished by means of X-ray examination. When this is done exographs of every foot of butt welding are made, and each film is examined carefully. When defects are found the faulty metal is chipped out and rewelded. The repaired portion is then re-exographed and the new film is studied to discover whether or not the new weld is satisfactory. By this means it is possible to produce practically perfect structures.

### Training of Operators

Today with the increasing demand for welding operators, most large companies find it necessary to train their own welders.

This is done by running regular training schools where men are given a set course. This generally takes about three months, after which the newly trained men are put to work in the shop tacking and doing a certain amount of unimportant welding. By degrees they are schooled on actual work, but under careful supervision, advancing stage by stage until they are thoroughly trained.

All welders have to pass qualification tests and they are graded accordingly. Those who work on pressure

vessels are specially qualified in accordance with the requirements of government departments having jurisdiction.

### Joints

The outstanding development in welded fabrication is in some measure due to the better understanding by engineers, in both office and shop, of the right way to design, detail and build structures in a manner suitable for arc-welded construction. Original designs are now made for welded structures rather than designs for riveted structures with arc welding substituted for riveting.

Something of what the engineer should know about welding in order to design welded structures of various kinds is indicated in the following discussion of joints.

The design of joints requires a great deal more than merely to provide for a definite amount of weld metal proportioned by dividing a calculated amount of stress by a specified unit.

Engineers appreciate that under some circumstances certain types of joints may involve unnecessarily high shop and field costs; and they must be capable of choosing the best joint for any particular condition.

The preparation of the material for certain kinds of joints is as important as the actual operation of welding; and the assembler controls the quality of the joint as much as the welding operator. The assembler must be careful to leave proper clearances, allow sufficiently for expansion and contraction, secure properly to prevent distortion and when necessary pre-set to allow for distortion.

To get a clear understanding of the comparative analysis of the joint types to follow it may be well to accept the general conditions 1, 2 and 3, which follow:

1. The best condition for welding is down hand on a flat surface (Fig. 5). Penetration is greatest under such circumstances because the current is concentrated over the whole area of the electrode cross section and all points on its surface are equidistant from the surface of the flat plate. The deepest penetration is directly under this area and decreases to zero at the boundaries of the arc flare.

2. Assume penetration in a vee (Fig. 6) or groove to be not more than to the root of the vee or groove, i.e., to the shoulders of the prepared edges. At times, somewhat more penetration than this may be obtained, but the assumption is safe and reliable.

3. The arc will take the shortest path and therefore may leave an unfused part when conditions are favorable for it as in Fig. 7.

In the following comparative analyses of joints it is assumed that conditions 1, 2 and 3, previously stated, are correct. Although all of the joints discussed may be used in construction under right circumstances they should be chosen to suit the specific work they have to do and the position in which they must be made.

Figure 8 indicates two $^3/_{16}$ inch or lighter plates with square edges butted closely together. On the basis of our assumption (1) this should give a full penetration as electrodes of the right size will penetrate $^3/_{16}$ inch under suitable conditions; in practice however, full penetration is impossible to obtain without the use of a backing bar. If full penetration were attained the plate would be melted through and if it were not melted through there would not be full penetration.

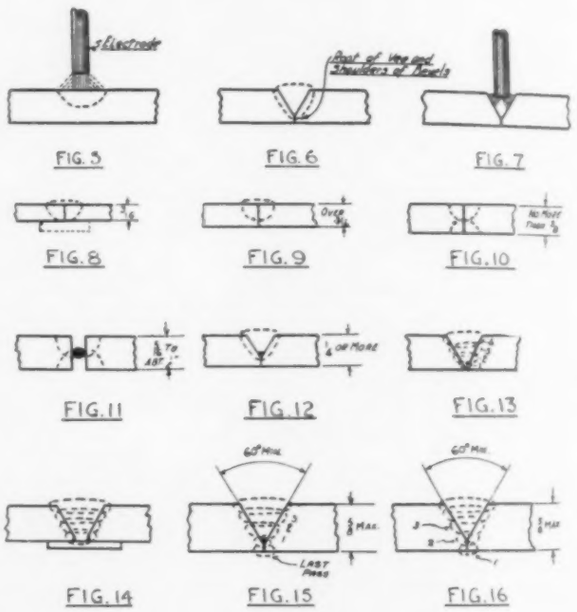
This joint, however, may be satisfactory for some purposes where load stresses and distortions are negligible.

Where plates over $^3/_{16}$ inch in thickness (Fig. 9) are connected in the manner shown there will undoubtedly be incomplete penetration, as $^3/_{16}$ inch is about the maximum penetration obtainable with an assurance of sound welding.

At the unfused portions of the abutting plates there is a point of very severe stress concentration. Authorities have stated that the stress concentration at this point under tension loading is from eight to twelve times the average stress.

Under certain circumstances this would appear to be a very dangerous joint, particularly in tension or bending.

The joint shown in Fig. 10 is excellent when special care is taken and sufficient consideration is given to electrode diameter, current, arc blow, length of seam and




ease of execution. These special conditions are necessary to make such a seam with perfect penetration and without slag.

Though structurally sound this seam, even with perfect penetration, would not pass some codes where chipping is specified. This weld may be made to satisfy such codes if one side is welded and the other side then chipped to solid weld metal and completed.

The weld as shown is good in tension, compression and bending and the square edges are particularly satisfactory for assembling.

Although the joint pictured in Fig. 11 will not have perfect weld throughout because of a segregation of slag and drippings at the bottom of the first pass it may be very satisfactory for cases where full strength is not the main feature. It is excellent for fast production, but it would not be acceptable to some codes because of the inevitable entrapped slag.

Figure 12 depicts a joint $^1/_4$ in. or more in thickness, welded from one side. Referring back to Fig. 6 and our condition 2 it will be noted that complete penetration is impossible here. This joint may be dangerous under load in a like manner to that shown in Fig. 9.

To make the joint in Fig. 13 practically perfect when welded from one side it is necessary to draw a light bead at the root with a small electrode very expertly handled. Subsequent passes may be made with larger electrodes.

This type of joint, however is difficult to assemble and provides very little resistance to contraction. There is likely to be an over-lapping of the adjoining edges with a consequent lack of penetration.

FIG. 17

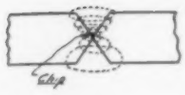



FIG. 18

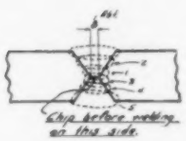



FIG. 19

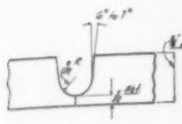


FIG. 20

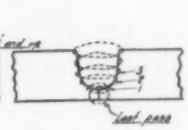



FIG. 20A

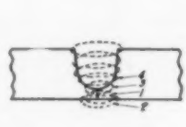


FIG. 20B

A perfect joint may be made by welding from one side when made as shown in Fig. 14, using a backing bar. The plates should be bevelled to a very small shoulder and be separated about the diameter of the electrode—slightly less for down hand and a little more for vertical welding.

In Fig. 15 the joint shown is bevelled from one side, leaving very small shoulders. The first pass is to the bottom of the vee and a small amount of slag may be trapped at the root. After the grooved side is completely welded the back of the joint is chipped to remove the enclosed slag, and then the last pass is run.

This joint can be made perfectly and can meet the highest code classifications.

The joint in Fig. 16 is almost the same as that shown in Fig. 15 and is of practically the same value regarding freedom from impurities. It differs in that the sequence of the passes does not require chipping. Because some codes arbitrarily specify the chipping of welds of certain classifications the use of this joint might be prohibited in many pressure vessels. It is excellent for vertical welding.

Figure 17 shows a joint which is very unreliable as far as full penetration is concerned, even though welded from both sides. Impurities will be left at the bottom of the grooves and they cannot be removed satisfactorily by chipping. There will almost assuredly be no penetration for the depth between shoulders.

A joint of the type shown in Fig. 18, bevelled from both sides and with the plates closely butting, which is required to be entirely free from entrapped impurities, will require chipping. Chipping of course is commonly done in high class work, but in this case too much work will have to be done as a great deal of parent metal will have to be chipped from the sides before the slag at the bottom can be removed and solid weld metal reached. A U-nosed chisel has to be used and it must be wide enough to take care of side undercutting caused by arc flare.

However, with the plates bevelled from both sides as in Fig. 19, and the edges separated as shown, it is possible and not too difficult to obtain a weld perfect from all standpoints. There may be some difficulty in running the first pass. After one side is completed it is necessary to chip to solid weld metal before making the first pass in the second groove. If much trouble develops in placing the first pass in the first groove very deep chipping will be necessary. The chipping, however, is easy of access because there is ample room.

When we reach plates of $^{3}/_{4}$ inch and upward in thickness the most satisfactory form of joint preparation is that shown in Fig. 20. Welds of the highest quality, entirely free from slag and porosity can be obtained. Satisfactory joints may be made from the styles shown in either Figs. 20A or 20B.

For the method shown in Fig. 20A it has been found beneficial to run a very light preliminary pass on the ungrooved side of the joint. This is helpful in preventing subsequent cracking during welding and also in controlling the arc blow. After the groove is completely welded the back must be chipped to solid metal. This of course cuts out all the preliminary backing bead involving a small waste of weld metal. Where this joint is welded in the sequence indicated the chipping must be done from the inside if the structure is a vessel. Very often this is awkward and difficult, especially in small vessels. Three inside operations are necessary, i.e., welding, chipping, welding.

When the joint has the welding passes made in the order shown in Fig. 20B a perfect joint can be obtained with a little more ease than by the method shown for Fig. 20A.

Two passes are first made on the ungrooved side and then the bottom of the groove is chipped from the outer or grooved side. The second pass of weld has provided plenty of metal to stand thorough chipping and leave enough material for an efficient backing for the groove weld.

The first pass is easy to make because it is against the flat plate, hence there will be a minimized danger of impurities. On vessels the only inside work involved is the laying of the first two passes of weld. The subsequent chipping and all the groove welding is done from the outside under conditions of much more ease and comfort for the operator.

So far this has proved the most satisfactory method of making high class welded joints in thick metal.

The joints so far compared are all of the butt type and are the kind generally used in the construction of pressure vessels. Structural steel parts are more often connected by means of fillet welds. In general a butt weld may be described as one in which the throat section is normal to the sections joined as in Figs. 21, 22 and 23, while in a fillet weld the throat section is inclined to the surfaces of the sections joined as in Figs. 24, 25 and 26. Butt joints are now nearly always made with covered electrodes.

Bare electrodes are still used a great deal for making fillet welds but many companies are rapidly reaching the point where they use only covered rods for that purpose.

The following comments on fillet welds therefore will have to be based on a consideration of both types of electrodes.

*Fillet Welds—Bare Electrodes—One Pass—(See Fig. 27)*

In earlier days of welding it was very common practice to use only one size of electrode, generally $^{5}/_{32}$ inch diameter, for most classes of work. This limited the size of the one pass fillet to about $^{1}/_{4}$ inch for good welds. Dan-

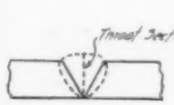



FIG. 21

FIG. 22

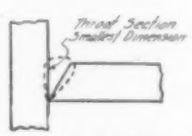



FIG. 23

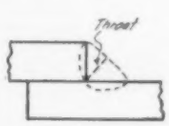



FIG. 24

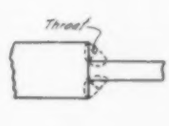



FIG. 25

FIG. 26

FIG. 27

FIG. 28

FIG. 29

ger lay in attempting to make larger single pass welds with this size of electrode. Today however, the *size of the electrode is chosen to suit the fillet* to be made.

Bare wire electrodes of $^5/_{32}$ inch in diameter will make one pass fillets of about $^1/_4$ inch, those of $^3/_{16}$ inch diameter will make a $^5/_{16}$-inch fillet and $^1/_4$-inch electrodes will make $^3/_8$-inch fillets. *The choice of electrode size also depends on the thickness of the materials* to be joined.

Large electrodes cannot be used on thin plate because the heat required for the electrode will be too great for the metal.

When making fillet welds it is essential that fusion must be complete to the root. To accomplish this the welder must not allow the root to become cool at the point of deposition at any time during the operation. To maintain this condition it is necessary to vary the electrode to suit the fillet.

The difficulty of obtaining full root penetration with bare electrodes varies with the position of the fillet. When the weld is being made in a vertical position the root condition is easily satisfied.

*Fillet Welds—Bare Electrodes—Two Pass—(See Fig. 28)*

In making two pass fillet welds with bare wire a very light string bead is first drawn along the root. This light bead easily affords full root fusion. The second pass is very easy to run because the ordinarily difficult root penetration has already been accomplished and arc blow conditions have been bettered.

*Fillet Welds—Bare Electrodes—Multiple Pass—(See Fig. 29)*

To make multiple pass, bare wire, fillet welds the same conditions for root penetration are observed as for two pass welds. Subsequent passes usually do not give much trouble, but particular care must be taken to get full penetration on horizontal surfaces.

Bare wire fillet welds may be made in all positions, i.e., flat, vertical and overhead.

*Fillet Welds—Covered Electrode—One Pass*

With covered electrodes fillet welds on the flat may be made very easily. Larger electrodes may be used when covered, the greater heat being absorbed in making the molten metal more fluid.

The welding technique is of the simplest possible kind —a straight draw with high current.

Root pentration does not give the same trouble as with bare wire since arc blow is lessened and the molten metal is in a more fluid state because of the greater heat.

Fillet sizes of $^3/_{16}$ inch to $^1/_4$ inch may be obtained with $^5/_{32}$ inch diam. electrodes; $^1/_4$ to $^5/_{16}$ inch with $^3/_{16}$ inch diam.; $^3/_8$ inch with $^1/_4$ inch diam., and $^7/_{16}$ to $^1/_2$ inch with $^5/_{16}$ inch diam. electrodes.

*Fillet Welds—Covered Electrodes—Multiple Pass*

Two pass fillet welds are rarely made when covered electrodes are used, since it is difficult to weave a second pass. Where very large fillets are necessary three or more passes are used.

With correctly chosen covered electrodes fillets are easily made in the flat position, but when they are used for vertical welding, the current must be cut to control the molten metal, as covered rods form an extremely fluid puddle.

In welding in a vertical position the general movement of the electrode may be either downward or upward.

It is difficult to obtain a good weld by downward vertical welding, but if it can be made the crystalline structure will be excellent. To make it the weld is deposited in thin layers and must proceed fast enough to keep ahead of the slag. The successive thin layers are self-annealing and consequently the quality of the weld is improved.

For upward welding with covered electrodes the fillet must be sufficiently large to allow of such a motion of the electrode tip (weave) that the trailing crater will always be stiff enough to carry the new molten metal above. If the tip of the electrode returns to the crater while it is still very fluid the metal will spill out.

Upward vertical welds can be made with fewer passes than the downward, and the slag is thick and easy to remove. Each layer of downward weld is covered with a thin tough slag which is difficult to remove. The weld made upward is easier to clean and is the one generally used for vertical welding with covered electrodes.

The remarks made above concerning vertical fillet welds are also true for covered rod vertical vee welding. Practice has shown that a V rather than a U is better for vertical welding.

## Composite Construction

Arc welding has made possible the development of the Kane System of composite structural steel and concrete construction.

In this system a steel skeleton is designed sufficiently strong to provide for all construction loads including the wet concrete. This steel later functions as reinforcing for the concrete beams of the structure. Relatively small sections may be used because no holes have to be deducted from the cross section of the parts and minimum dimensions are not limited by the gages and edge distances required for riveted types of structures. The

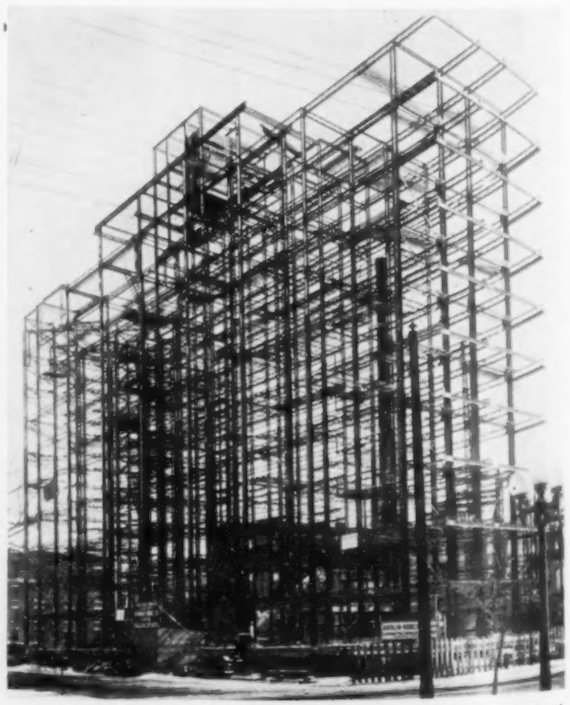


Fig. 30—All Welded Steel Addition to Western Hospital, Montreal, Designed for Composite Construction

Fig. 31—Arc-Welded Continuous Deck Plate Girder Bridge at Ste. Anne de la Perade, P. Q.

open web system of the beams provides very convenient openings for duct work and piping. The Western Branch of The Montreal General Hospital was designed and built to this system (see Fig. 30).

### Welded Bridges

Steel bridges of a very pleasing appearance are easily developed by arc welding. In addition to the improved aesthetic effect a very definite saving in steel tonnage is possible.

The bridge at Ste. Anne de la Perade on the Montreal-Quebec highway is a very fine example (see Fig. 31). This whole structure, consisting of several continuous deck plate girder spans with the lower chords shaped to the lines of a flat arch, was shop fabricated entirely by the arc welding method and all field joints and connections were welded.

A saving of 15 per cent was made in the weight of the girders by designing them for continuity; and an additional 15 per cent in weight was saved by fabricating the structure by arc welding instead of riveting.

In connection with arc-welded fabrication it is interesting to note that the Canadian Engineering Standards Association is developing a code to standardize the workmanship on arc-welded structures by a scheme to qualify shops, supervisors and welding operators in order to develop a uniformly high quality of welded building construction throughout Canada.

### Conclusion

In concluding this article it may be well to repeat what has already been said by many others.

To obtain first class welding it is essential that there be intelligent design, sound shop procedure, adequate supervision, strict inspection by the shop's own inspectors while the work is being done and a chain of responsibility from the chief engineer to the welding operator.

The future of welding is hard to predict, but if it be judged by the rate of its accelerated development in the last five years, it will embrace an amazingly large proportion of steel structures.

### Acknowledgment

The writer wishes to thank Mr. David Boyd of the Canadian Car and Foundry Company Limited and Mr. Gordon Cape of the Dominion Bridge Company Limited for helpful suggestions and also the companies mentioned in this article for information regarding their welding progress.

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# Development of Covered Electrode Arc Welding*

By A. M. CANDY†

WITHIN relatively recent years the use of covered electrodes in this country has taken a predominant position, and they are now sold in large tonnage quantities. In fact, covered electrodes are rapidly superseding bare electrodes. However, covered electrodes were first developed in England and marketed in the early 1900's. These rods were introduced into the United States, but the cost plus duty restricted their use and adoption on anything but a small scale.

During the early stages of covered rod development and manufacture the cost of production was relatively high, and as a result the selling price showed a large spread above bare rod prices. However, by improving production methods and by the substitution of high-speed machines for production the cost of covered rods has been reduced to the previous prices obtained for bare rods.

The manufacture of covered rods is not as simple as some persons might think. Between the various analyses of steels and non-ferrous base rods to be used and the almost unlimited combinations of natural materials that can be used in the coatings or coverings the field of the research chemist and metallurgist becomes almost staggering.

There are a large number of objectives to be obtained by means of rod coverings among which are the following: Increase the melting rate of the rod and base metal. Make the arc more stable. Minimize spatter loss of molten metal. Improve physical properties of weld metal. Make equally good welds with positive or negative polarity. As a result of these developments, welds having physical properties equal to or better than the base metal can be made in any of the steels including all alloys and in the non-ferrous field including aluminum, copper and others.

Just to give an idea of the improvement made in mild steel welding we give the following table, which shows the comparative results of making a weld with bare wire, and a suitably covered rod.

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* Abstract of paper to be presented before the A. I. & S. E. Annual Convention, Chicago, Ill., Sept. 28, 29, 30, Oct. 1, 1937.

† Consulting Engineer, Hollup Corporation, Chicago, Ill.

| Property | Bare Rod | Covered Rod |
|---|---|---|
| Ultimate tensile strength | 50,000 | 65,000 |
| Yield point | | 51,000 |
| % Elongation in 2 inches | 4–10% | 25–30% |
| Brinnell hardness | 185 | 160 |
| Impact (Izod) | 5–10 | 60 |
| Fatigue limit | 10,000–12,000 | 30,000–32,000 |
| Specific gravity | 7–7.5 | 7.85 |

As a result of improved weld properties the field of application of electric welding has been expanded vastly. The cost of producing many structures has been decreased. Furthermore many structures can now be welded with safety and assurance so that they will not fail in service where they are subject to shocks, alternating loadings or alternating pressures or temperatures.

One of the largest presses ever produced is entirely welded. The press is approximately 29 ft. long, 28 ft. high and 6 ft. wide, and weighs approximately 750,000 lb. Covered electrodes were used on all main stress carrying members of this press.

Probably no machinery equipment receives more abuse nor is subjected normally to tougher service requirements than road building machinery. In fact, the very largest equipment of this type is arc welded, and could not be constructed satisfactorily in any other way.

The extensive use of covered electrodes for the past fifteen years in the petroleum industry is undoubtedly well known to all of you.

A field which is absolutely dependent upon the use of covered electrodes is that of various grades of stainless steel. Kitchen fittings including tables and cupboards are typical examples of stainless clad steel fabrications produced entirely with covered electrodes.

The hard surfacing field is also dependent upon covered electrodes of various types. In the construction field where excavating machinery is used, the dipper buckets and teeth are built up with covered high manganese rods. This same material is used for restoring special track work such as manganese frogs and crossings. In the hard surfacing field where high abrasive action must be resisted by members made of cast iron, excellent results are obtained by employing special coated rods for cast iron.

Probably one of the outstanding developments of recent years is the rapid expansion of welding in the construction of railroad cars, both passenger and freight. In the case of passenger cars much of the welding is done by the spot-welding process, and one railroad in particular has applied the process to a portion of its freight car construction. However, even here a considerable proportion of the welding is done with the covered electrode arc process.

When the car construction involves main framing the covered electrode process of welding is inherent. Cars of this type are made with one or more of the relatively new high strength steels, and therefore require special electrodes. In this particular case the covered electrode used produces weld metal having an ultimate tensile strength of 80,000 to 100,000 pounds and ductility of 25% elongation in 2 inches.

Another outstanding example of mass application of covered electrode arc-welded construction is that of the Duryea cushion underframe for railway freight cars and cabooses. Ten years ago only fifty cars were so equipped whereas this year the total will reach at least 24,000, more than 11,000 of which have been equipped within the last two years.

Probably the most interesting new development in welded construction is an all arc-welded locomotive boiler just finished by the Delaware and Hudson Railroad with the permission of the Interstate Commerce Commission. This boiler is being put in service as a stationary boiler for a preliminary period of six weeks after which it will be put in regular road service on a standard D. & H. R. R. Class E-6-A locomotive.

Space will not permit a detailed description of this boiler but a few principal items will be of interest. The main "barrel" portion is a frustum of a cone being 88 inches outside diameter at the smokebox end and 94 inches outside diameter at the firebox end. The plate thickness is $1^1/_{16}$ inches. The working pressure is 225 pounds per square inch. All welds in the boiler shell were stress relieved in line with the A. S. M. E. Boiler Code for power boilers, before the firebox was attached. Before the shell was placed in the furnace the "mud ring" was bolted to the shell to stiffen it. The flat and circular parts of the shell were also thoroughly braced, and as a result there was no change in contour resulting from the 1150° F. temperature in the furnace.

Truly, we are at the threshold of an age of welding. One could go on and on citing examples, but these are sufficient to indicate the trend of the times.


## CONVENTION NUMBER!

IN ORDER to make the Annual Meeting Papers generally available a limited number of copies of the October WELDING JOURNAL are being placed on sale—50 cents per copy to members and $1.00 per copy to non-members. Here is an opportunity to place in the hands of your friends, a book of 172 pages of the latest welding information at a nominal charge. The Society reserves the right to limit the number of copies sold to any one member.

# Influence of Volt-Ampere Characteristics on Penetration

By N. FRAZIER*

## Introduction

THERE has been much debate about the effect of the static and dynamic volt-ampere characteristics of the welding generator on the weld. It seems indisputable that arc stability increases as the slope of the dynamic characteristic increases, but other relations have been put forward without a solid foundation in fact. The variation of penetration with the slope of the static characteristic of the welding generator is one of these.

## Test Procedure

Since no theoretical considerations lead to any interrelation between these two factors, a series of tests was made to determine the facts in this question. In these tests an automatic welding head was used in order to eliminate the personal element as completely as possible. For open-circuit voltages from 250 to 100 volts, a 250-volt, 400-ampere shunt generator supplied the welding power through a reactor and resistor. Between 50 and 100 volts, a 60-volt multiple-operator welding generator was used with the same circuit. In this way nearly straight static characteristics with open-circuit voltages ranging from 50 to 250 volts were made available for the tests. Without any change in the shape of the static characteristic, its slope was varied in 25-volt steps within the available range, as shown for one welding voltage in Fig. 1.

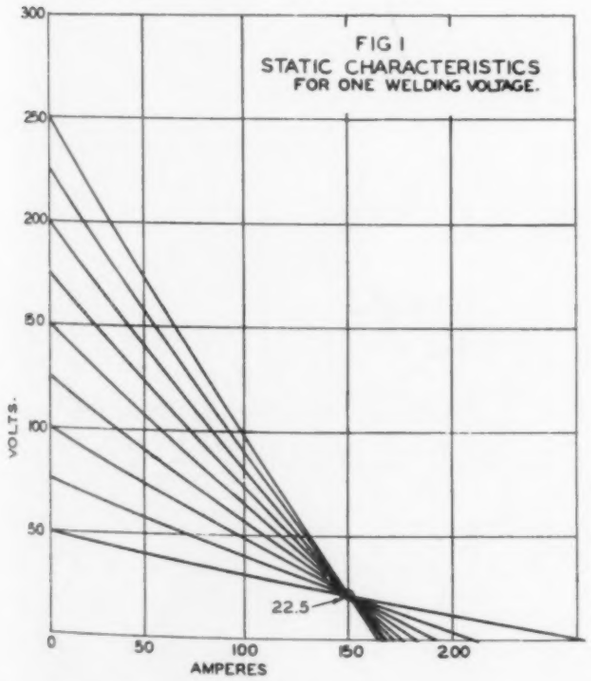
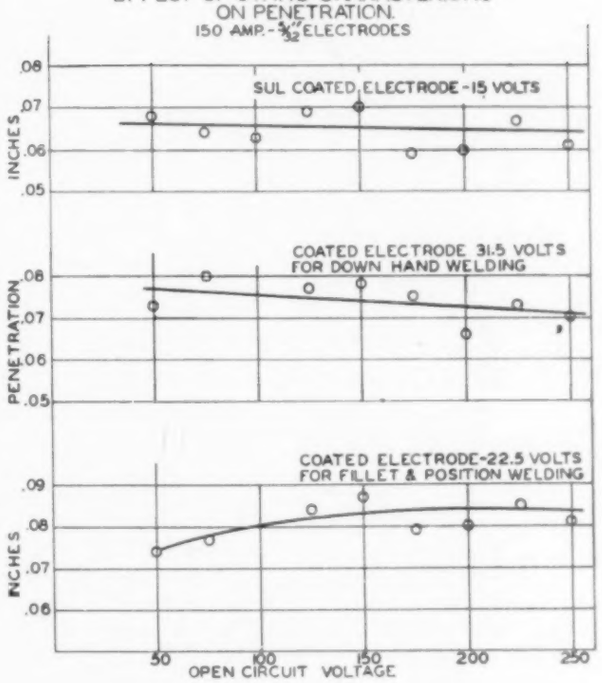



FIG. 2.
EFFECT OF STATIC CHARACTERISTIC ON PENETRATION.
150 AMP.-5/32" ELECTRODES




Three types of electrodes were tested. To represent the bare class of welding wire, a "sul"-coated rod was selected; among the coated types, electrodes designed for down-hand welding and for high speed fillet welding were chosen. Each type was tested over the entire range.

Beads about seven inches long were deposited on $^1/_2$ inch thick mild steel plate with a $^5/_{32}$-inch electrode, one bead for each test point and three beads on each side of the plate. The plate was cooled between each run. No tendency for the penetration to vary with the position of the bead on the plate could be found. Current, voltage and welding speed were kept as constant as possible for each type of electrode, but some variations

* Engineering Department, Westinghouse Electric & Manufacturing Co.

occurred unavoidably. However, the irregularity of results cannot be traced to these influences.

### Test Results

Each plate was cut through in two places on a cutting wheel. This permitted four cross sections to be etched and measured with an accuracy not above 0.01 inch. The results did not justify any greater accuracy of measurement. The following is a table showing the average penetration for the four sections measured:

Table 1—Average Penetration

| Open-Circuit Voltage | | 50 | 75 | 100 | 125 | 150 | 175 | 200 | 225 | 250 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Coating | | | | | | | | | | Conditions |
| Penetration in Inches | "Sul" | 0.068 | 0.064 | 0.063 | 0.069 | 0.070 | 0.059 | 0.060 | 0.067 | 0.061 | 15 v.—150 amps.—9.3 in./min. |
| | DH | 0.073 | 0.080 | ... | 0.077 | 0.078 | 0.075 | 0.066 | 0.073 | 0.070 | 31.5 v.—150 amps.—9.0 in./min. |
| | FP | 0.074 | 0.077 | ... | 0.84 | 0.087 | 0.079 | 0.080 | 0.085 | 0.081 | 22.5 v.—150 amps.—9.0 in./min. |

These results are plotted in Fig. 2 to a scale which somewhat exaggerates their irregularities.

### Conclusions

There can be no question about the interpretation of these results. Penetration is independent of the slope of the static volt-ampere characteristic of the welding generator used. Although these tests were made only in the down-hand position, there appears, leaving aside the factor of stability, to be no reason to doubt that this conclusion can be applied to all positions.

The dynamic characteristic of a welding generator is rather difficult to define since many variable factors enter into its shape. However, it appears certain that a change from 250 to 50 volts in the no load voltage would effect markedly the slope of the dynamic characteristic. Thus, it can be stated positively that penetration is not effected by the slope of the volt-ampere characteristics of the welding generator.

However, the static and dynamic volt-ampere curves are indications of certain other features of a welding generator. A steep slope is indicative of good stability, but a high-peak voltage is dangerous to the operator. These considerations now become the dominating factors (since penetration has been ruled out), determining the most desirable shape of characteristic.

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# Statement of the Ownership, Management, Circulation, etc.

REQUIRED BY THE ACTS OF CONGRESS OF AUGUST 24, 1912, AND MARCH 3, 1933

OF THE AMERICAN WELDING SOCIETY JOURNAL, published monthly at Easton, Pa., for October 1, 1937.

State of New York } ss.
County of New York }

Before me, a Notary Public in and for the State and County aforesaid, personally appeared William Spraragen, who, having been duly sworn according to law, deposes and says that he is the Editor of the AMERICAN WELDING SOCIETY JOURNAL and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit:

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W. SPRARAGEN, Editor.

Sworn to and subscribed before me this 23rd day of September, 1937. (Seal) MARY T. HICKEY

Notary Public, New York County Clerk's No. 158.
New York County Register's No. 8-H-344.
(My commission expires March 30, 1938.)

# Wrinkle Bending—A Method for the Field Fabrication of Pipe Bends*

By R. B. AITCHISON†

A RELATIVELY new method for bending pipe has been developed which promises considerable economies in the field fabrication of overland pipe lines. This method, known as "wrinkle" bending, consists of upsetting the pipe *outwardly* up to approximately one half of its circumference so that the pipe with its length shortened slightly on one side by wrinkling will deviate from a straight line by the angle resulting from the upset. In practice, an oxyacetylene flame is used to heat one or more narrow bands at right angles to the pipe and extending about half-way around the pipe. The pipe is then bent either by hand or by means of a tractor, and the heated sections slightly buckled.

The process is analogous to shop-fabricated creased bends, only the wrinkle or crease is not so pronounced. As a rule, wrinkling is used to produce only a slight change in direction of the pipe. When the bend is more pronounced a series of wrinkles are used to give an easy flow, long sweep bend. The wrinkles project outward, thus providing a full opening throughout the bend. The method has found its greatest favor in mountainous country where, obviously, the greatest amount of bending is necessary, and where cold bending is difficult to handle because of the rough terrain and heavy equipment required.

Wrinkle bending has been used for several years in the construction of natural gas pipe lines and is applicable from the smallest to the largest size pipe. Excellent results have been obtained on 4- and 6-in. diameter pipe and equally good results have been obtained on the larger sizes ranging all the way up to 22 inches in diameter. The method is adaptable to both heavy wall and light wall pipe and can be performed in the shop as easily as it can in the field. In either instance, the bend is "tailor-made" to fit the job.

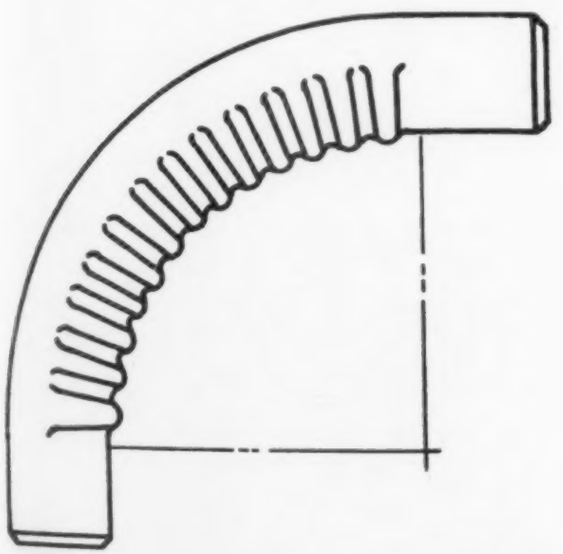

Fig. 1—Wrinkle Bent Overland Pipe Is Somewhat Similar in Appearance to This Shop-Fabricated Creased Quarter Bend, Only the Creases or Wrinkles Are Not So Pronounced or Numerous Since It Is Usually Necessary to Produce Only a Slight Bend in the Pipe

Fig. 2—Wrinkle Bending by Lifting the Pipe Against the Heated Portion. Only One Blowpipe Is Necessary on Small-Diameter Pipe. Two Blowpipes Are Recommended for Pipe Over 6 Inches in Diameter

## Procedure for Small Diameters

Two oxyacetylene blowpipes are required for pipe 6-in. in diameter and over. The large capacity blowpipes designed for heavy heating operations are particularly suitable for wrinkle bending. Additional equipment consists of either a manifolded supply of dissolved acetylene, or an acetylene generator, and a supply of oxygen. The oxygen is not usually manifolded. As a rule, both gases are hauled along the right-of-way on a sled. Trained welding operators are not required, as the process involves only a simple heating operation.

In field fabrication, the bending or laying foreman decides where a bend is necessary. This may be a side, sag or overbend. If the pipe is of small diameter, 6 inches for instance, no additional bending equipment is necessary. The section of pipe is laid on skids across the ditch and the foreman marks the point at which the pipe is to be bent. The heaters, standing on each side of the pipe, then proceed to apply heat to this point around approximately one-half to two-thirds of the upper circumference of the pipe. The band of heat should be 2 to 3 inches wide at the top of the pipe and should taper down to zero on the two sides. The pipe should be heated to a bright red.

When the pipe is at the correct temperature, the section should be rolled over quickly so that the heated portion is on the underside. At the same time, one of the pipe gang should throw the skid on which one end of the pipe is resting into the ditch. This man should then press, if necessary, on his end of the pipe while the other end is being held securely by two additional men. The weight of the pipe itself is usually sufficient to form the wrinkle, and the man in the ditch often finds his chief work in holding the sagging pipe to the requirements of the bend.

* Presented at Annual Meeting, AMERICAN WELDING SOCIETY in Atlantic City, N. J., week of Oct. 18, 1937.

† Division Representative, Process Service, The Linde Air Products Company.

Fig. 3—Flexibility, Economy and Dependability Are Features of the Wrinkle Bending Method for the Field Fabrication of Pipe Bends. Five "Wrinkles" Were Required in This Bend to Fit It to the Contour of the Terrain

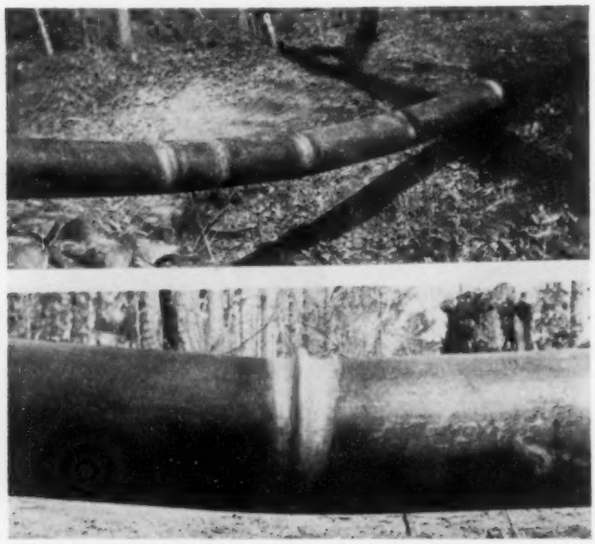

Fig. 4—A Close-Up of a Wrinkle Bend. Note How the Pipe Upsets Outward, Thus Providing a Full Opening Throughout the Bend. Depression Squeezes the Pipe So That the Metal at the Bend Is Slightly Thicker Than the Original Wall

This operation is repeated until sufficient wrinkles have been formed to give the required bend. In general, a wrinkle of 5 to 7 deg. should be the maximum to which the pipe is bent. A greater total bend is obtained by using more wrinkles. Wrinkles may be at any distance from one another, although it is more desirable to produce long sweeps wherever possible rather than short angle bends.

The entire procedure should not require more than $2^1/_2$ to 3 minutes. All three types of bend—sag, side and overbend—may be readily produced in one section of pipe.

## Procedure for Large Pipe

Additional equipment is necessary if the pipe is large or lying alongside the ditch or on the ground prior to ditching. If a tractor is used it should be equipped with a stiff leg. The tractor should run part way onto the timbers which hold the pipe in place, the stiff leg set in position, and the chain block attached. The chain block in turn is fastened to the pipe. The pipe should then be heated in the usual manner and, when the proper heat is reached the free end should be pulled up by means of the chain block.

Another method for handling this type of work is to use a tripod or "A" frame equipped with block and tackle. One end of the pipe should be temporarily anchored, the heat applied and the free end then hoisted to form the wrinkle. Still another method using the same equipment is to hoist the pipe first, place one or two men at one end to steady the pipe, and one or two men at the other end to press down. Heat is then applied on the underside of the section, and the wrinkle is formed by the weight of the sagging pipe.

If the pipe is of the usual low-carbon type, the bend can be arrested at any time by sudden cooling with water. However, this practice is not recommended for high-strength pipe. In wrinkle bending longitudinally welded seam pipe, the heat should preferably be placed 180 deg. away from the seam. This is not always possible, as, for example, when an overbend or sag and a side bend are to be made in the same section of pipe.

Where just a small angle is required, the wrinkle need not necessarily extend the full half of the circumference. The flexibility of the process permits the foreman to put in just the right amount of bend at just the right places.

## Comparison with Other Methods

Other methods for bending overland pipe include cold bending, fire bending and miter joint welding. The latter method is costly, however, since it involves both cutting to pattern and welding. Also, it is undesirable for high-pressure transmission lines since it tends to increase turbulence and hammer. Multi-piece bends or fabricated bends are imminently satisfactory, but are costly and too slow for overland construction.

Cold bending is an excellent means of bending low-carbon pipe, especially the smaller diameters. However, when the pipe is large, the pipe wall thin, and the pipe of high strength, cold bending should be employed only if handled by a competent bending expert, as the danger of the bend buckling inward is great.

Unless great care is exercised when making the lift in cold bending a point will be reached when the pipe can no longer resist the stresses. If the lift is then continued, the pipe is apt to collapse at the point where the bend is being made. Such a collapse, of course, is undesirable as indicated by the stress marks radiating from the buckle on the steel surface. Should a leak subsequently develop at this point, it will be virtually impossible to repair it, even temporarily, with the ordinary leak clamp. In addition, cold bending generally requires the services of two tractors. Hence, the equipment cost is high.

The usual method for handling fire bending is to raise the pipe off the ground and light a fire under the point where the bend is to be made. The pipe will then sag when the steel has been heated sufficiently to stretch. The principal disadvantages of this method are that it requires considerable time and fuel. Also, the bend is

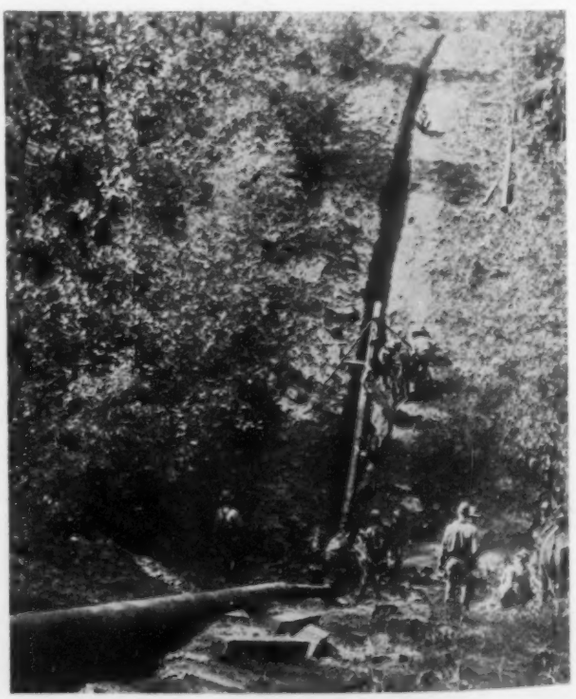

Fig. 5—The Relatively Sharp Bend in This 8-Inch Gas Line Has Been Formed by Wrinkle Bending. Seen in This View Is the Entire Crew Required for the "Stove-Pipe" Method of Laying Pipe. Wrinkle Bending Fits In Particularly Well with the All-Position or Stab-On Methods of Welding

not under particularly good control, and overheated sections of the pipe wall are apt to thin out. Generally speaking, cold bending is preferred to fire bending.

### Advantages of Wrinkle Bending

The advantages of wrinkle bending are many. Particularly important is that the pipe wall is never thinned from the original. On the contrary, compression squeezes the pipe so that the metal at the wrinkle is actually slightly thicker than the original wall.

Wrinkle bending lends itself readily to correction, since too much bending in one or more wrinkles may be corrected simply by reheating and a reverse pull or sag. Furthermore, the pipe is not stressed as in cold bending because the bend takes place only at the point where the steel has been softened by heating. The facility with which bends are formed makes for the ready fabrication of gradual or long sweep bends that are so desirable in overland pipe line construction.

Another important feature of wrinkle bending is its low cost. Equipment costs, labor costs and materials costs are all low. Also, the method permits bending even before the ditch is cut. Wrinkle bending fits in very well with the all-position or stab-on methods of welding.

The method has literally no disadvantages. Occasionally, through false economy, an effort is made to obtain too much bend at one or more wrinkles, resulting in depressions on the inside of the pipe. For ordinary transmission this may not be a serious factor, but in high-pressure lines, such as the main line from a series of wells, depressions may lead to the entrapment of condensate and to freezing. However, this condition can be avoided by following correct bending practices.

The wrinkle bend lends itself readily to the fabrication of large degree bends even up to 180 deg. These may be made in the shop and then fitted on the job. Pumping station piping equipment is an example of this type of work.

Again, where the terrain is very rough and the pipe size very large, wrinkle bending can be carried out adjacent to the railroad siding where the pipe is being unloaded. The bent sections are then hauled out by the pipe stringing trucks and placed where needed. This is of special value in composite construction.

All in all, wrinkle bending offers the pipe line contractor a fast, inexpensive, dependable method for the field fabrication of pipe bends.

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# Modern Ship's Doctor

By A. F. DAVIS*

KEEPING many a vessel from the graveyard of ships by mending broken or worn parts of hull and propelling machinery, the modern ship's doctor "heals" the injured stern frame of the cargo ship "Alabaman" of the American Hawaiian Steamship Co. at the Oakland, California yard of the Moore Drydock Co. The ship's doctor (arc-welding operator) "sews up the wound" with the electric arc using molten shielded-arc-weld metal.

* Vice-President, The Lincoln Electric Company.

# Blade Warpage Overcome

By R. K. KENNEDY*

### Improved Method Also Reduces Finishing Costs

THE use of hard-faced scraper blades for keeping rolls clean is constantly broadening. Machines employing such blades are now used in a variety of industrial operations, including bread dough molding, the "mechanical kneading" in bakeries; flour mill rolling; and paper making. Such blades are employed successfully wherever cutting or scraping is continuous and free from impact or shock to the blade.

The experience a middle-western concern has had with flour mill roll scraper blades has resulted in an important development which facilitates the manufacture of these blades. The scrapers, which when finished are $2^1/_2$ inches wide, and hard-faced along the top edge, are made from strip steel $2^3/_4$ inches wide and $^3/_8$ inch thick. The steel strips are cut to the proper length—in this case, 42 inches—and grooved on one side. As shown in Fig. 1, the groove is $^1/_{16}$ inch thick and $^1/_2$ inch wide, extending the full length of the blade $^1/_8$ inch away from the edge.

* Haynes Stellite Co.

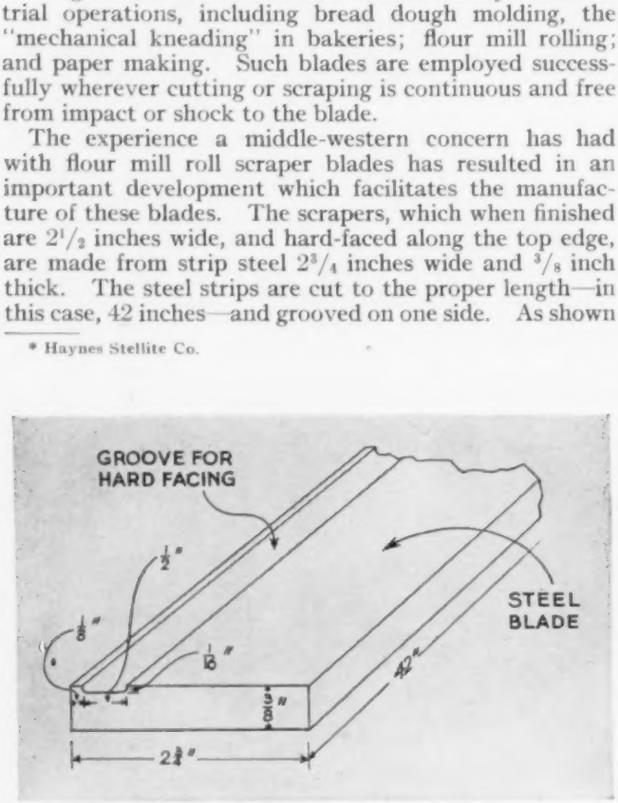


Fig. 1—Steel Strip Grooved in Preparation for Hard-Facing

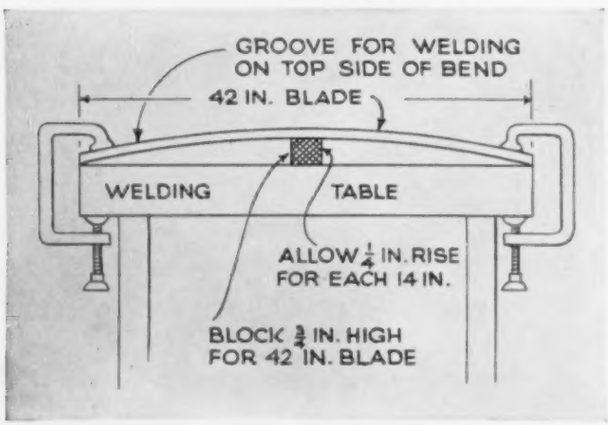
GROOVE FOR WELDING ON TOP SIDE OF BEND
42 IN. BLADE
WELDING
TABLE
ALLOW $\frac{1}{4}$ IN. RISE FOR EACH 14 IN.
BLOCK $\frac{3}{4}$ IN. HIGH FOR 42 IN. BLADE

Fig. 2—Arrangement for Bending Blade During Hard-Facing Operation

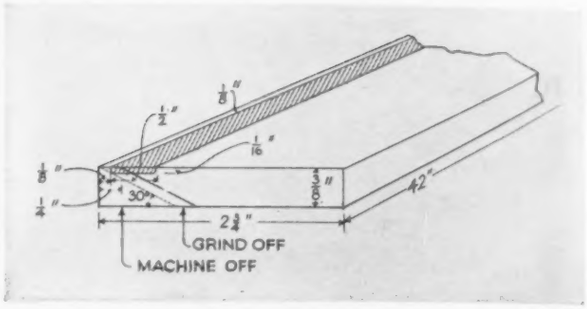


Fig. 3—Hard-Faced Blade Showing Method of Machining and Grinding

During the hard-facing operation, a blade is clamped at both ends to a welding table. A block under the center of the blade gives a reverse curve to the side which is to be hard-faced. In this case, the height of this curve amounts to $^1/_4$ inch in every 14 inch of total length—$^3/_4$ inch for a 42-inch blade. The method of mounting is shown in Fig. 2. This manner of bending the strip during the welding operation has been found to overcome subsequent warpage. The C-clamps are removed immediately after welding is completed. As it cools, the bar returns to a flat position, or is still slightly bowed and is straightened by pressure until flat. This method of application puts the hard-facing material under compression. If this method is not used, the heat of the welding operation curls the blade and in straightening the hard-facing may crack, as it is then in tension.

After the strip has cooled, the edge is machined off at a 30° angle up to the under side of the hard-facing. From this point, it is ground to the desired contour. The metal removed by machining and grinding is indicated in Fig. 3. When finished, the blade appears in cross section as shown in Fig. 4. It has been found that this method insures a very sharp point on the finished blade, and a substantial edge is produced with a minimum waste of hard-facing alloy.

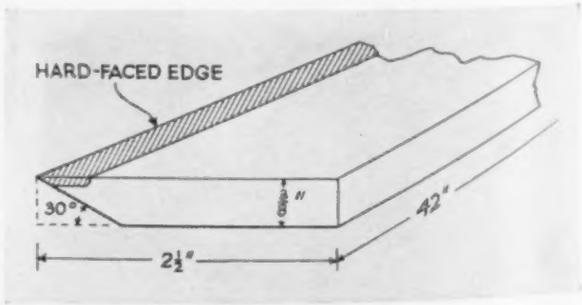


Fig. 4—Completed Blade Showing Hard-Faced and Sharpened Edge

This same method of preventing distortion by reverse bending has been previously employed in the fabrication of welded headers, a series of pipe junctions or nozzles emerging from one side of a feeder. In this operation it has worked out very successfully. However, for applying hard-facing materials, the method has not been very widely used, but it should find application in the hard-facing of many types of long blades or strips upon which the hard-facing alloy is to be applied longitudinally.

Experience will show the correct amount of curvature to be applied to any other particular part. In the case described, S.A.E. 1035 steel, $^3/_8$ inch thick, was employed, and the amount of bending was $^1/_4$ inch for each 14 inchs of length. Steels of higher or lower carbon content will require a larger or smaller degree of bending due to the fact that they have different rates of thermal expansion. The thickness of the strip also has a bearing on the matter, since a thicker strip will not distort as much relatively as will a thinner strip.

The elimination of preheating and the saving of hard-facing alloy has already insured the economy of this process, and the saving of time and labor will undoubtedly prove this a most practical method for the production of straight, precision-made, hard-faced blades.

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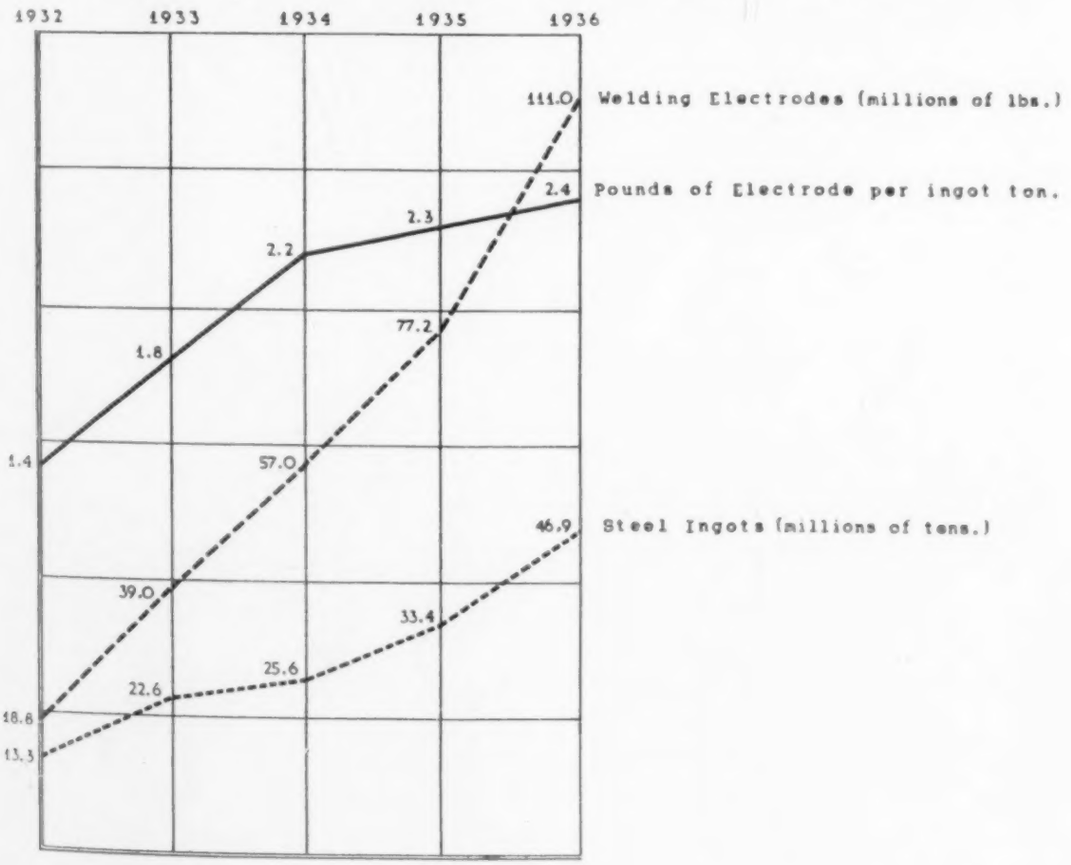
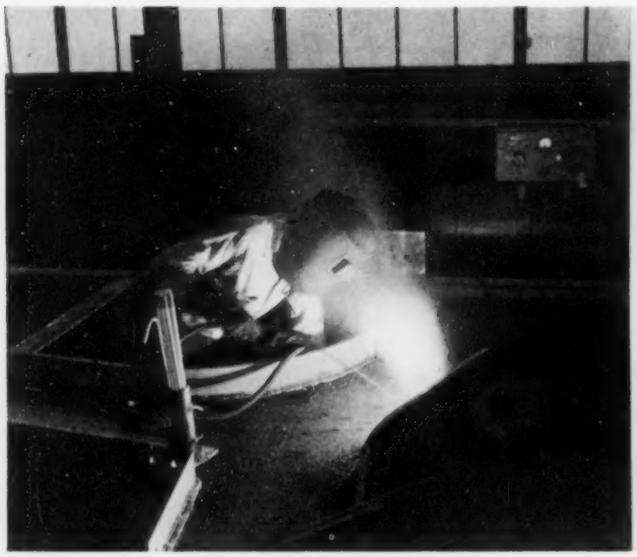
# Arc Welding Forges Ahead

By H. L. CARD*

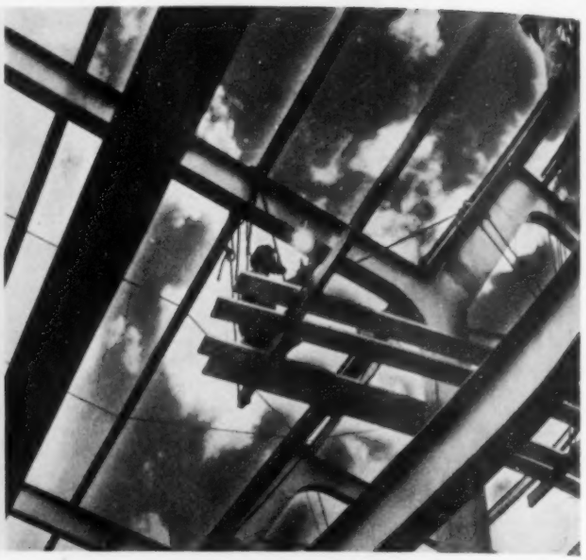
TRUE to the predictions that were made for it a decade ago, the electric arc-welding process has been making tremendous strides in extending its fields of usefulness. The growth in volume in the past five years is clearly shown by the NEMA reports of electric welding wire consumption, from 18.8 millions of pounds in 1932 to 111 millions of pounds in 1936. It is thought in some quarters that there will be recorded a further 50% increase when the total for 1937 is known. That this progress is not all due to the general revival of industrial activity is shown by the steady increase in volume of consumption in the early thirties, before any real revival had started. A more graphic proof is the increasing amount of electrodes being used for each ingot ton of steel poured. In 1932 the figure was 1.4 pounds of electrode for each ingot ton; in 1936 this figure had reached 2.4 pounds, an increase of 71%. 1937 activities indicate that the trend is still definitely upward. In general, this growth may be ascribed to the fact that the shielded-arc process make possible a quality of weld deposit that has won engineering acceptance in nearly all the major fields of steel construction and fabrication. Prominent naval engineers have stated that the riveted ship is on the way out, barge and tanker construction for inland waterways is largely an all-welded job, railroad freight cars are being welded in thousand lots, the petroleum industry is building larger pressure vessels whose service practically demands arc-welded construction and approves the process for fabrication of all kinds of containers and piping systems, machinery from the smallest up to the most massive mill equipment is using welded structures to replace castings. These high spots are showing the way and establishing confidence in arc-welded structures. The old limitations have been nearly all swept away, some of them within just a few years, and arc welding forges ahead.

* National Electrical Manufacturers Association, Electric Welding Section.





"Tree-Form" Section Permits Effective Utilization of Steel in Structural Members



Fusing Two Members of Structural Steelwork Directly Together Without Use of Intermediate Connecting Members

# All Welded Industrial Plant

## 200,000 Sq. Ft. Welded Rigid Frame Plant to Be Completed October 1st, Less Than 100 Working Days in Design and Erection

By A. S. LOW*

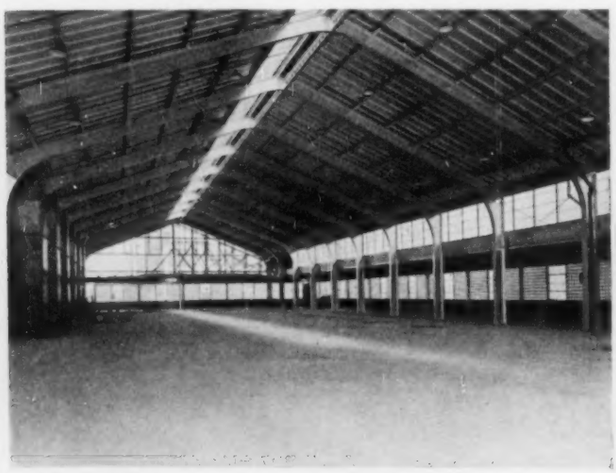
CONSTRUCTION of a 200,000 sq. ft. industrial plant in a period equaling that ordinarily required to build an average size residence is being achieved at the Lincoln Electric Company arc welding equipment factory at Cleveland, Ohio. This modern arc-welded rigid steel frame addition to the Company's manufacturing plant will be finished October 1st, within 100 working days of the date on which The Austin Company received instructions to proceed with its design and construction.

The new two-story plant introduces "tree-form" columns developed by Austin engineers to provide unobstructed space from floor to roof in 40-ft. aisles throughout an 80,000 sq. ft. sawtooth section. All cross members are eliminated throughout this area, as in the lofty "cathedral" bay which has an 80-ft. clear span.

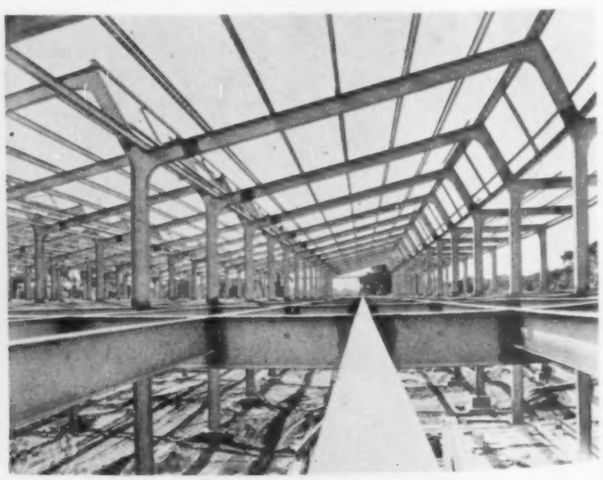
Glass block has been used extensively throughout the structure in which functional design has been applied to produce an efficient and attractive plant. It is characterized by the most modern heating and ventilating equipment, with continuous heat valves for natural ventilation through the roof, which is of cement tile and has a bonded waterproof surface.

Installation of equipment by the owners is to begin shortly.

* Vice-President and Chief Engineer, The Austin Company.



Lofty 240-Ft. Cathedral Bay of the Second Floor. A Total of 12,600 Linear Ft. of Welding Required of Which Only 4100 Ft. Was Welded on Site



Welding Floor Beams at the Second Story Level. 1314 Tons of Steel Used

# Qualifying Welding Operators for Important Work

EDITOR'S NOTE: *The question is often raised as to how one goes about qualifying an operator for important work. A preliminary report covering several industries was published in the August 1937 issue of* THE WELDING JOURNAL. *Below is given a reply from the Bureau of Construction & Repair, U. S. Navy. Additional comments are invited.*

## NAVY DEPARTMENT

### Bureau of Construction and Repair

OPERATORS used on Navy work must demonstrate their ability annually to do arc welding by passing those of the following tests which are applicable to the work that they are to do with the materials that they are to use.

To qualify on structural work of limited thickness ($^3/_4$ inch or less), the operator shall prepare butt weld test plates in $^3/_8$ inch plate material in the vertical and overhead positions Fig. 1. Specimens cut from these plates with all reinforcing and backing removed shall be capable of passing root and face bends to the full capacity of the bending jig shown in Fig. 7, without developing any cracks in excess of $^1/_8$ inch measured in any direction.

To qualify on structural work of unlimited thickness, the welding operator shall prepare butt weld test plates in $^3/_4$-inch plate material in the flat and vertical positions from which test specimens are cut as shown in Fig. 2. These specimens shall be capable of passing root and face bends to the full capacity of the bending jig Fig. 7 without developing any cracks in excess of $^1/_8$ inch measured in any direction.

Fig. 1—Welders' Qualifications Tests No. 1

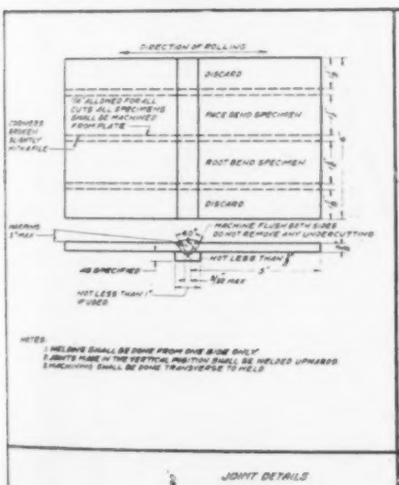

DIRECTION OF ROLLING
DISCARD
FACE BEND SPECIMEN
ROOT BEND SPECIMEN
DISCARD
MACHINE FLUSH BOTH SIDES DO NOT REMOVE ANY UNDERCUTTING
NOTES:
1. WELDING SHALL BE DONE FROM ONE SIDE ONLY
2. JOINTS MADE IN THE VERTICAL POSITION SHALL BE WELDED UPWARD
3. MACHINING SHALL BE DONE TRANSVERSE TO WELD

Fig. 2—Welders' Qualifications Tests No. 2

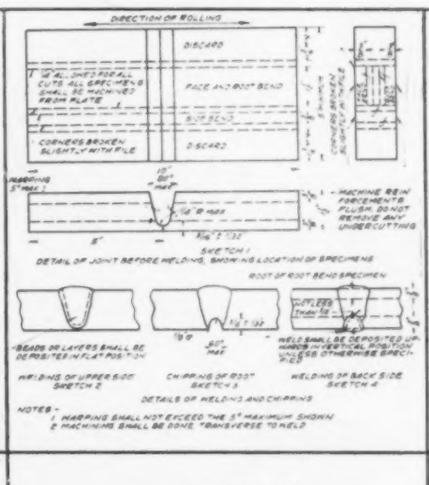

DIRECTION OF ROLLING
DISCARD
FACE AND ROOT BEND
SIDE BEND
DISCARD
MACHINE REINFORCEMENTS FLUSH, DO NOT REMOVE ANY UNDERCUTTING
SKETCH 1
DETAIL OF JOINT BEFORE WELDING, SHOWING LOCATION OF SPECIMENS
ROOT OF ROOT BEND SPECIMEN
GROOVED
WELDING OF UPPER SIDE SKETCH 2
CHIPPING OF ROOT SKETCH 3
WELDING OF BACK SIDE SKETCH 4
DETAILS OF WELDING AND CHIPPING
NOTES:
1. WARPING SHALL NOT EXCEED THE 5° MAXIMUM SHOWN
2. MACHINING SHALL BE DONE TRANSVERSE TO WELD

Fig. 3—Welders' Qualifications Tests No. 3

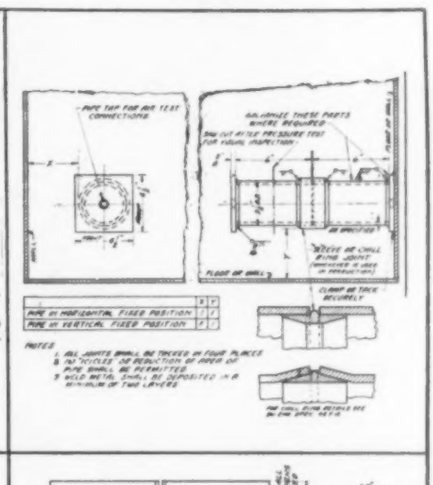

PIPE TAP FOR AIR TEST CONNECTIONS
REINFORCE THESE PARTS WHERE REQUIRED
FOR FINAL INSPECTION
SLEEVE OR CHILL RING JOINT (WHICHEVER IS USED IN PRODUCTION)
FLOOR OR WALL
CLAMP OR TACK SECURELY
PIPE IN HORIZONTAL FIXED POSITION
PIPE IN VERTICAL FIXED POSITION
NOTES:
1. ALL JOINTS SHALL BE TACKED IN FOUR PLACES
2. NO "CYCLES" OF REDUCTION OF SPEED OF PIPE SHALL BE PERMITTED
3. WELD METAL SHALL BE DEPOSITED IN A MINIMUM OF TWO LAYERS

Fig. 4—Welders' Qualifications Tests No. 4

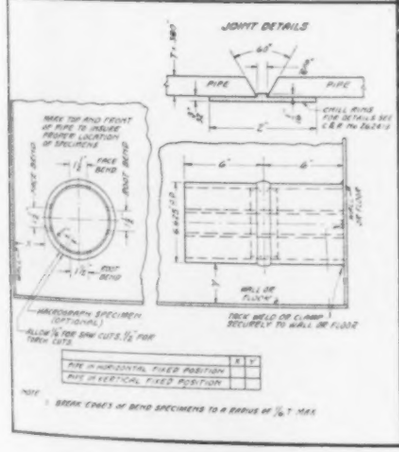

JOINT DETAILS
PIPE
PIPE
CHILL RING FOR DETAILS SEE C & R No. 34243
MAKE TOP AND BOTTOM OF PIPE TO INSURE PROPER LOCATION OF SPECIMENS
FACE BEND
JOINT BEND
ROOT BEND
WALL OR FLOOR
MACROGRAPH SPECIMEN (OPTIONAL)
TACK WELD OR CLAMP SECURELY TO WALL OR FLOOR
ALLOW 1/16" FOR SAW CUTS 1/16" PER TORCH CUTS
PIPE IN HORIZONTAL FIXED POSITION
PIPE IN VERTICAL FIXED POSITION
NOTE: BREAK EDGES OF BEND SPECIMENS TO A RADIUS OF 1/16" T MAX

Fig. 5—Welders' Qualifications Tests No. 5

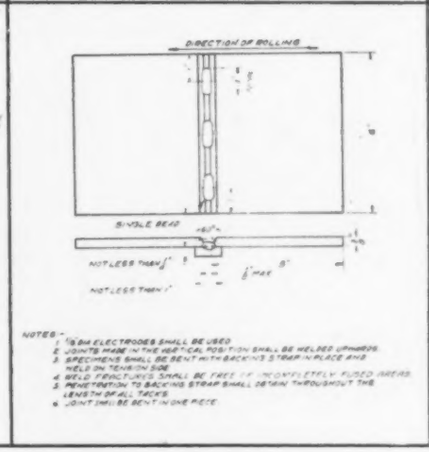
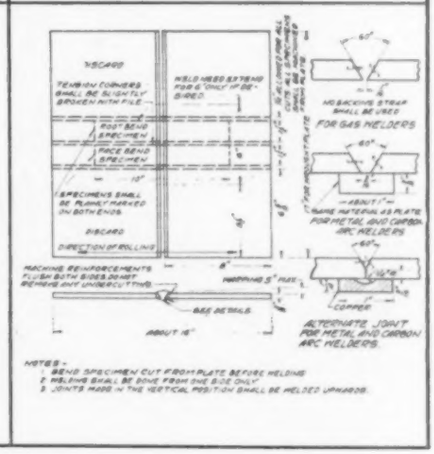

DIRECTION OF ROLLING
SINGLE BEAD
NOTES:
1. 1/8" DIA ELECTRODES SHALL BE USED
2. JOINTS MADE IN THE VERTICAL POSITION SHALL BE WELDED UPWARDS
3. SPECIMENS SHALL BE BENT WITH BACKING STRAP IN PLACE AND HELD ON TENSION SIDE
4. WELD FRACTURES SHALL BE FREE OF INCOMPLETELY FUSED AREAS
5. PENETRATION TO BACKING STRAP SHALL OBTAIN THROUGHOUT THE LENGTH OF ALL TACKS
6. JOINT SHALL BE BENT IN ONE PIECE

Fig. 6—Welders' Qualifications. Tests No. 6 (For Base Metals of High Conductivity)


DISCARD
TENSION CORNERS SHALL BE SLIGHTLY BROKEN WITH FILE
WELD BEAD EXTEND FOR 6" ONLY AT END
ROOT BEND SPECIMEN
FACE BEND SPECIMEN
SPECIMENS SHALL BE PLAINLY MARKED ON BOTH ENDS
DISCARD
DIRECTION OF ROLLING
MACHINE REINFORCEMENTS FLUSH BOTH SIDES DO NOT REMOVE ANY UNDERCUTTING
BASE DETAILS
NO BACKING STRIP SHALL BE USED FOR GAS WELDERS
SAME MATERIAL AS PLATE FOR METAL AND CARBON ARC WELDERS
ALTERNATE JOINT FOR METAL AND CARBON ARC WELDERS
NOTES:
1. BEND SPECIMEN CUT FROM PLATE BEFORE WELDING
2. WELDING SHALL BE DONE FROM ONE SIDE ONLY
3. JOINTS MADE IN THE VERTICAL POSITION SHALL BE WELDED UPWARDS

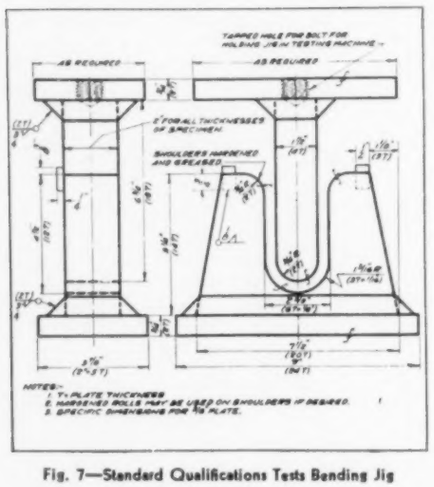


Fig. 7—Standard Qualifications Tests Bending Jig

To qualify on pipe and tubing of $^3/_{16}$ inch or less wall thickness, pipe samples as shown in Fig. 3, shall be prepared by the welding operator. These specimens shall not leak when subjected to a hydraulic pressure sufficient to impose a hoop stress equal to the yield of the material. The welding operator shall have passed the test for structural materials of limited thickness before attempting this test. If the welding operator is to weld this class of pipe in the shop only, the sample pipe shall be rolled and the welding done in the flat position.

To qualify on pipe and tubing of $^3/_4$ inch or less wall thickness, pipe samples shall be prepared by the welding operator and test specimens cut from them as shown in Fig. 4. These specimens shall be capable of passing root and face bends to the full capacity of the bending jig Fig. 7 without developing any cracks in excess of $^1/_8$ inch measured in any direction. Welding operators qualified by this test are considered qualified on the preceding tests.

Welding, operators to be used as tack welders are qualified by preparing the test shown by Fig. 5.

Before welding metals of high conductivity, test samples as shown in Fig. 6 are prepared by the welding operator and tested in the bending jig.

The qualification of gas-welding operators is essentially the same as arc-welding operators, except that structural work of unlimited thickness and tack welding are not done by gas welding.

Table No. 2 is used to record the results of the operator's qualification.

TABLE No. 2.
U.S. NAVY DEPARTMENT
RECORD OF QUALIFICATION OF FUSION WELDERS

EMPLOYER _____ LOCATION OF PLANT _____

| TEST SERIAL No. | PROCESS | BASIC METAL | FILLER METAL | | FLUX TYPE | QUALIFICATION TEST | | INSPECTED SIGNATURE AND DATE |
|---|---|---|---|---|---|---|---|---|
| | | | MFR. BY | TYPE | | No. | POSITION PASSED | |
| | | | | | | | | |
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REMARKS:

WELDER'S IDENTIFICATION
SIGNATURE _____
ADDRESS _____ CHECK No. _____ DATE _____
LAST NAME — FIRST NAME — MIDDLE NAME
SHEET No. _____

# "Fatigue Tests of Butt Welds in Structural Plates"*

By W. M. WILSON

## Discussion by JONATHAN JONES†

THE author states in opening, that the "fatigue strength" is arbitrarily based upon 2 million cycles. Before the earlier program was determined for the fatigue tests of riveted joints, the opinion of several railroad bridge engineers was sought, and it was agreed that 2 million cycles of maximum-to-minimum stress is a reasonable expectancy for the main members of a railroad bridge.

There will however be many other structures, such as highway bridges, derrick parts, etc., for which the number of cycles of maximum-to-minimum stress will probably be far less; which makes it desirable to know the fatigue strength at lesser numbers of cycles as a basis for design.

Hence, the desirability of undertaking, as the author did, to obtain failure at a half million, one million and two million cycles.

It does seem to the writer, however, that in so doing, and in then undertaking to calculate the two-million cycle stress from the stresses at considerably fewer cycles, the author has been forced to rely on an arbitrary formula which has decreased, rather than increased, the probable accuracy of the final averages, at 2 million cycles.

Referring to Table 3, and considering the series with suffix 7, we find an estimated average of 27,900. But one specimen which was stressed only to 27,300 endured only 1,538,000 cycles. It seems to the writer more reasonable to assume from this one specimen that a true average for 2,000,000 cycles would be *less* than 27,300 than to assume from other widely separated data that it would be *more*.

In the series with suffix 6, the estimated average is 21,800, but the one specimen which was stressed only to 20,400 broke at 927,000 cycles and is a poor indication that as much as 21,800 would be endured to 2,000,000 cycles.

It would seem to the writer that the "*S-N* curves" must fall more rapidly with increase of "*N*" than the author has assumed. However, the errors in the averages cannot be large. It is clearly indicated that a large number of specimens will be required for a thorough program of research, to iron out the accidental variations and obtain reliable averages at several points on the *S-N* curves.

It is interesting to note that for all butt welds in carbon steel except those intended to be inferior, the estimated average fatigue strength is 24,000 and the lowest individual value is 20,400. In the A.W.S. specifications for welding of bridges, the unit tension allowed for stress-cycles from zero to a maximum is 13,500 on symmetrical, reinforced butt welds, and 15 per cent less on butt welds made from one side onto a backing strip. The data submitted by Professor Wilson tally very well with those allowables. It is to be hoped that the work can continue until all the *working* values in the bridge specification are thoroughly proved in or amended.

* Presented at Annual Meeting, AMERICAN WELDING SOCIETY, Oct. 19, 1937.
† Chief Engineer, Bethlehem Steel Company.

# What Developments in Welding Should Be Considered in Revising Specifications?*

By M. WANDELT

THE new German Code for welded boilers went into effect June 1st of this year. The Code applies to stationary and mobile boilers and pressure vessels for use on land, fired direct or indirect. The Code does not apply to vessels heated by steam and its application to marine boilers is still under consideration. The present paper discusses the conditions that gave rise to the Code and then describes the detailed requirements of the Code.

Reviewing the present state of development of welding, Wandelt concludes that plain carbon steels up to 0.55% C can be welded satisfactorily with suitable heavy covered electrodes and that cracking is not an important matter in boiler welding. Among the most important developments in welding have been:

1. Automatic welders for covered electrodes. For circumferential seams the drum is rotated; for axial seams the drum is stationary and the welding head travels.
2. The realization of the embrittling effect of fractional percentages of oxides and nitrides in welded joints.
3. The use of machining and heat treatment to improve welded joints. Machining removes notches and raises the fatigue resistance of welded boilers in repeated pressure tests.

The problems of heat treatment are by no means solved. The factors involved are type of steel and vessel, shrinkage stresses and economy. The use of straps with the object of strengthening welds is no longer considered good practice, because the straps actually decrease the fatigue resistance of a welded joint.

The development of non-destructive methods of testing has been almost as important as the advance in quality of welding. The most important methods are X-Ray and Magnaflux, but gamma rays and magneto-acoustic methods are also useful. The problem of correlating mechanical properties with the results of non-destructive tests is extraordinarily difficult but important. The lack of a satisfactory solution to this problem is holding back the full utilization of non-destructive methods.

The steels permitted at the present time for welded boilers are listed in Table 1. Hitherto, in accordance with riveted design, the "strength factor V" has been defined as the ratio of the minimum tensile strength of the welded joint tested in the direction of the weld to the tensile strength of unwelded base metal. It is now regarded as the ratio of weld to base metal with respect to all significant properties, e.g., impact value, bend ductility and fatigue strength.

The tensile strength of the steels listed in Table 1 ranges from 50,000 psi to over 100,000 psi. The carbon content of steels for fusion welding in no case exceeded 0.3%, for water gas welding 0.18%.

*The New Specifications*

Developments in welding are reflected in the new specifications. Although the new Code represents a noteworthy advance over earlier ones from the standpoint of the rigid training of personnel, both welders and inspectors, it contains a completely revised section on heat treatment. The Code of 1926 required all welded boilers to be normalized.

It is universally realized that the normalized boiler is the best. Normalizing removes the coarse grained zone in the welded joint and also removes residual stresses caused by welding. Normalizing has a pronounced effect on notch impact value (cross section of fracture: 0.59 x 0.59 inch). High grade oxyacetylene and arc welds average 7 mkg./cm.$^2$ as welded, but 15 mkg./cm.$^2$ after normalizing. On the other hand, Table 2 and Fig. 1 show that improper normalizing may give inferior re-

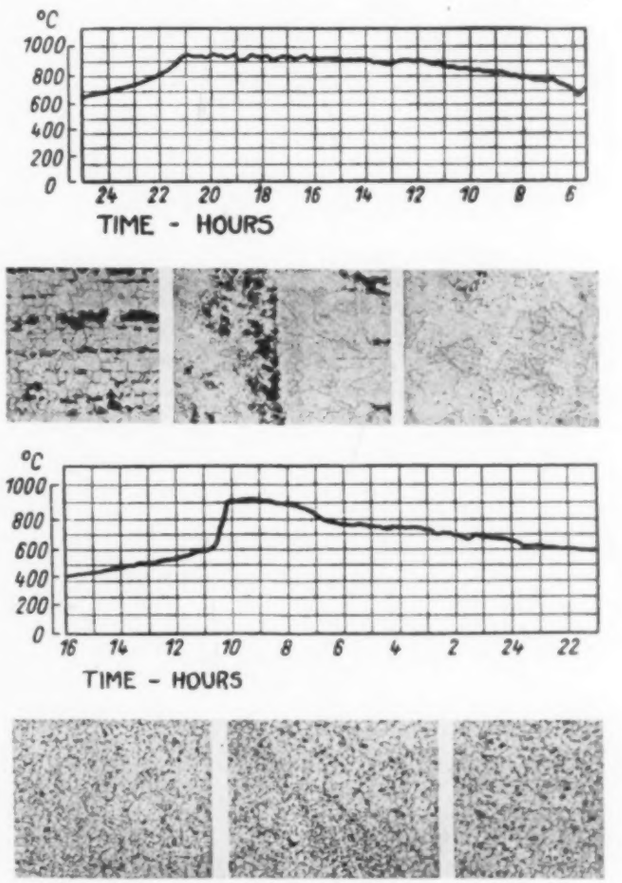



Fig. 1—Effect of Time at Normalizing Temperature and of Cooling Velocity on the Structure of a High-Tensile Arc Weld. 200×
(Upper) Incorrect Normalizing
(Lower) Correct Normalizing

* (Published in *Die Wärme*, 60, Nos. 28 and 29, pages 439–448 and 455–462, July 1937.)
Extended Abstract by G. E. Claussen, research assistant, Welding Research Committee.

**Table 1—Steels Allowed for Welded Boilers and Pressure Vessels in Germany**

| Type of Steel | Symbol | Tensile Strength, psi | Alloying Elements, % | Method of Welding | Used for | Strength Factor |
|---|---|---|---|---|---|---|
| Unalloyed Mild Steel | ..... | 49,800–79,700 | ..... | Arc | Boilers & Pressure Vessels | 0.9 |
| Molybdenum Steel | ..... | 49,800–79,700 | 0.5 Mo | Arc | Boilers & Pressure Vessels | 0.9 |
| Copper-Molybdenum Steel | Th30R | 58,300–75,400 | 0.2 Cu, 0.25 Mo | Arc | Boilers & Pressure Vessels | 0.9 |
| Age-Insensitive Mild Steel | Izett | 66,900–79,700 | ..... | Arc | Boilers & Pressure Vessels | 0.9 |
| Age-Insensitive Copper - Molybdenum Steel | KU33(St47K) | 66,900–79,700 | 0.25 Cu, 0.25 Mo | Arc | Boilers & Pressure Vessels | 0.9 |
| Corrosion Resistant Steel | V2A | 78,200–113,800 | 18.0 Cr, 8.0 Ni | Arc | Pressure Vessels | 0.9 |
| Corrosion Resistant Steel | V4A | 78,200–99,600 | 18.0 Cr, 8.0 Ni, 2.5 Mo | Arc | Pressure Vessels | 0.9 |
| Corrosion Resistant Steel | Remanit 1880S | 85,300–106,700 | 18.0 Cr, 8.0 Ni | Arc | Pressure Vessels | 0.7 |
| Corrosion Resistant Steel | Remanit 1880SS | 85,300–106,700 | As above with addition of Mo | Arc | Pressure Vessels | 0.7 |
| Corrosion Resistant Steel | Deutro 9S | 71,100–85,300 | 15.0–19.0 Cr | Arc | Pressure Vessels | 0.7 |
| Corrosion Resistant Steel | Deutro D16 | 64,000–85,300 | 15.0–19.0 Cr | Arc | Pressure Vessels | 0.7 |
| Unalloyed Mild Steel | ..... | 51,200–71,100 | ..... | Water Gas | Boilers & Pressure Vessels | 0.9 |
| Age-Insensitive Mild Steel | ..... | 62,600–75,400 | ..... | Water Gas | Boilers & Pressure Vessels | 0.9 |
| Copper-Molybdenum Steel | Th30R | 66,900–79,700 | 0.2 Cu, 0.25 Mo | Water Gas | Boilers & Pressure Vessels | 0.9 |

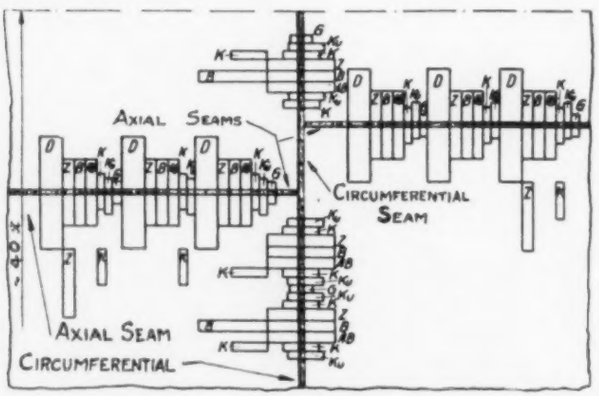



**Fig. 2—Arrangement of Specimens Required for Test Plate. (German Boiler Code, 1937)**

*D* = Pulsating tension fatigue specimen
*Z* = Tensile specimen
*B* = Cold bend specimen
*AB* = Quench bend specimen
*K* = Notch impact specimen
*Ku* = Notch impact specimen—notch in junction zone between weld metal and base metal
*G* = Specimen for microstructural examination
Diameter of drum = About 40 inches

**Table 2—Effect of Time of Normalizing and Velocity of Cooling on the Mechanical Properties of a High Quality Arc Weld**

| | First Normalizing | | | Second Normalizing | | |
|---|---|---|---|---|---|---|
| | Extreme Values | | Average | Extreme Values | | Average |
| Tensile Strength, psi. | 57,500 | 58,300 | 57,700 | 58,000 | 59,800 | 58,300 |
| Bend Angle, Degrees | 180 | 180 | 180 | 180 | 180 | 180 |
| Bend Elongation, % in 0.78 inch | 48 | 50 | 49 | 55 | 55 | 55 |
| Notch Impact Value, mkg./cm.² | 7.6 | 12.1 | 10.2 | 20.4 | 24.5 | 22.0 |

The first normalizing was 9 hrs. at 900–940° C.; cooled in closed furnace. The second normalizing was 1¾ hrs. at 900–910° C.; cooled in open furnace to 650° C.; cooled in closed furnace below 650° C.

Cross section of fracture of notch impact specimen was 0.59 x 0.59 inch.

sults. The improperly normalized joint has pearlite colonies agglomerated at the junction between coarse-grained weld metal and finer-grained base metal. The second normalizing has restored good structure and impact value. The furnace doors were closed at 650° C. during treatment 2 in order to prevent the development of shrinkage stresses.

In view of the desirable effects of normalizing, the new Code retains the clause "after the last weld is made the part must be normalized." Normalizing is defined as "heating uniformly just over the upper critical point, holding at this temperature 1 minute per millimeter of thickness (at least 20 minutes), followed by the proper cooling." Local annealing is permissible only for vessels of exceptional dimensions.

Special conditions must be met by boilers that are only stress relief annealed (600 to 650° C.). The vessel must be designed on the basis of a strength factor of not higher than 0.7; the vessel must be inspected by a non-destructive method; and the welded joint must be specially ductile. The manufacturer of small boilers, in particular, should find these conditions of little importance in comparison with the savings in heat treatment and supporting costs and should be able to replace riveted with welded construction. Stress relief annealing may increase the notch impact value only one-half as much as normalizing. The increase in impact values is believed to be related to release of internal stress. Stress relief annealing has no effect on the overheated zone of water gas welds and therefore is not permitted for water gas welded boilers.

Relatively unimportant welds only may be used without heat treatment of any kind. These are indicated in Table 3 which also summarizes the provisions of the new Code bearing on heat treatment.

By raising the "strength factor" of all welding processes to at least V = 0.7 the new code has opened new fields for welding in boiler construction. Table 4 shows the ratio of plate thicknesses of seamless forged, riveted and welded drums according to the new Code. The difference of 6% in thickness that still prevails in favor of the riveted boiler is usually counterbalanced by

**Table 3—Summary of Heat Treating Requirements of New German Code for Welded Boilers**

| | The Usual Case (Section B4) | | | |
|---|---|---|---|---|
| Normalize the entire welded part above Ac3 | | | | |
| Normalizing in parts | For vessels of extraordinary dimensions and special construction after permission from the appropriate authority. The final circumferential weld in this case must be normalized locally and preferably from both sides by means of a ring burner (Section B4) | | | |
| Stress-relief anneal the entire welded part at 600 to 650° C. | Fusion Welded Flues and Drums if:<br>1. Strength factor ≦ 0.7<br>2. Non-destructive test of all welds<br>3. Proof of sufficient ductility (Section B5c) | | In special cases involving low pressures with the permission of the Boiler Authority (Section B5b) | For repair welds the boiler authority decides whether and what heat treatment is necessary (Section E) |
| Not heat treated | Fusion Welded Flues and Drums if:<br>1. P ≦ 114 psi<br>2. $K_2$ ≦ 59,800 psi<br>3. $\sigma_s$ ≦ 6,000 psi<br>(P = internal pressure; $K_2$ = tensile strength of base metal; $\sigma_s$ = design stress in weld.) (Section B5dI) | Small boiler parts and attachments such as small supports. Also circumferential welds in superheater tubes as well as cover plates on some fire and water tubes (Section B5d II) | Fire Boxes, Water Legs, Fire Hole Welds, Fusion Welded Fire Tubes (Section B5d III) | |

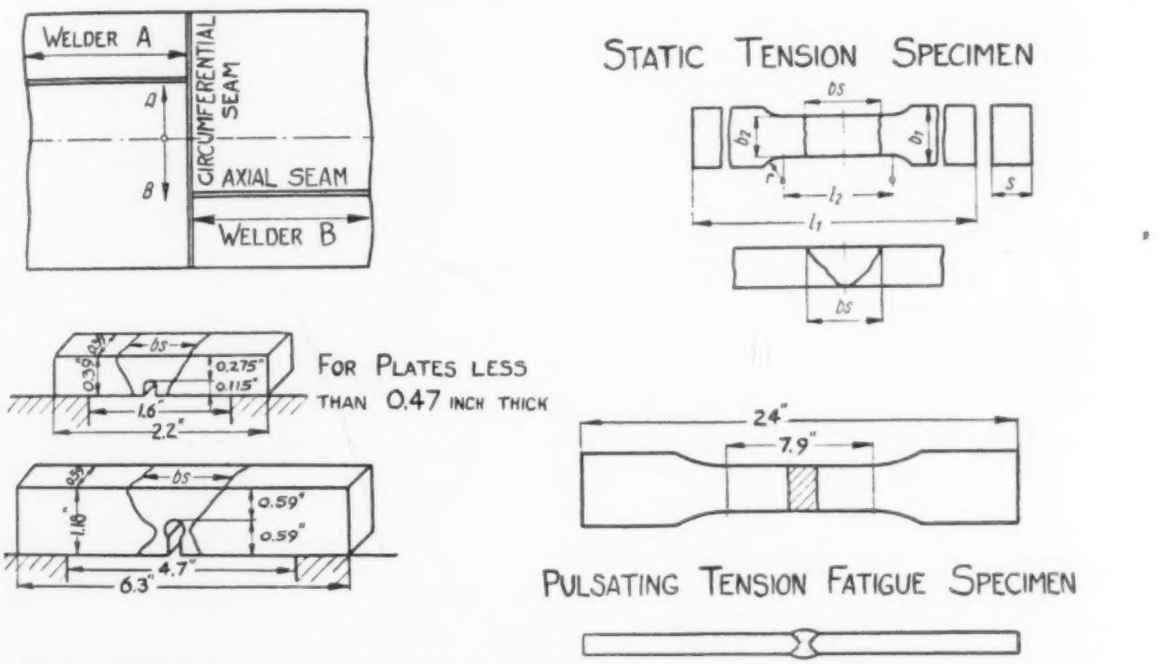



**Fig. 3—Dimensions of Specimens (German Boiler Code, 1937) Machining and Shape of Scarves Are Those Commonly Used by the Plant in Question**

| Dimensions (inches) of tension specimen are: | | | |
|---|---|---|---|
| $s$ | 0.39 to 0.98 | 0.98 to 1.37 | 1.37 to 1.77 |
| $l_1$ | 10.0 | 11.8 | 13.7 |
| $l_2$ | Breadth of weld: $b_S$ + 0.20 to 0.39 inch | | |
| $b_1$ | 1.18 | 1.37 | 1.58 |
| $b_2$ | 0.79 | 0.98 | 1.18 |
| $r$ | 0.59 | 0.79 | 0.98 |

The smaller notch impact specimen is used for junction zone tests and if the plate thickness is less then 0.47 inch. (DVMR specimen.)

The larger notch impact bar is used for plate thicknesses less than 1.18 inches.

The cross section of the pulsating tension fatigue specimen is 2.5 to 3.0 sq. in.

the extra weight in straps required by the riveted boiler.

If a firm desires to employ a "strength factor" greater than 0.7, it must apply to the Boiler Inspection Board giving particulars of welding process, type, thicknesses, and properties of base metal and filler rod, the maximum wall temperature, and whether or not the weld is to be subjected to dishing or flanging operations. The Board then:

1. Assesses the plant's equipment and methods of inspection.
2. Evaluates the experience of the welding personnel.
3. Performs mechanical tests on specimen welds.

Generally the specimen is welded in the thickest plate and by the most difficult method that the plant con-

**Table 4—Ratio of Plate Thicknesses of Seamless Forged, Riveted and Welded Drums According to the New German Boiler Code**

| Method of Fabrication | Strength Factor | Ratio of Plate Thickness for Equal Strength |
|---|---|---|
| Seamless Forged | ..... | 100% |
| Riveted | Single row, Single strap | 200% |
| Riveted | Single row, Double strap | 151% |
| Riveted | Multiple row, Double strap | 111% |
| Water Gas Welding | V = 0.7 | 151% |
| Water Gas Welding | V = 0.9 | 117% |
| Fusion Welding | V = 0.55 (1926 Code) | 192% |
| Fusion Welding | V = 0.7 (1936 Code) | 151% |
| Fusion Welding | V = 0.9 (1936 Code) | 117% |

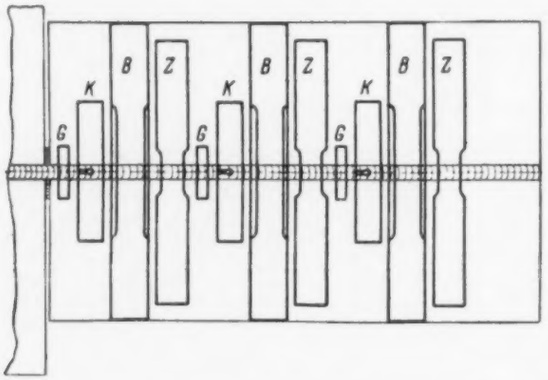



**Fig. 4—Arrangement of Test Specimens in Test Plate Welded with Each Drum Designed on a Strength Factor Over 0.7 Under Permission of German Boiler Authority, 1937**

G = Specimen for microstructural examination
B = Bend specimen
K = Notch impact specimen
Z = Tensile specimen

templates using. The arrangement of test pieces cut from the specimen weld is shown in Fig. 2. The dimensions of the specimens themselves are given in Fig. 3. Only the smaller impact specimen is used for testing the impact value of the junction zone between weld metal and base metal. The bend test is of the roller bend type on a machined specimen. The Wöhler curve (six or more specimens) obtained from the fatigue test (pulsating tension, 1400 to 2800 psi lower stress) must extend to $2 \times 10^6$ cycles. The specimens are cut from a drum at least 40 inches in diameter. Other tests may be prescribed if:

1. The proposed wall temperature is over 350° C.
2. Age-insensitive materials are to be used.
3. Corrosion-resistant materials are to be used.

If the Board tests are passed, every welded part made under the higher "strength factor" must be inspected by X-ray (all welds) and must be accompanied by a test plate Fig. 4 welded simultaneously with the part under consideration. The tensile strength must be at least 95% of the design strength of the base metal. The cold bend angle must be 180° (plunger diameter equal to, or 2 or 3 times the plate thickness, depending on quality of steel). The notch impact value also must equal or exceed 8 to 12 mkg./cm.$^2$ (large VGB specimen) depending on quality of steel. The weld, transition zone and base metal must possess a normalized microstructure. It may be remarked that in 700 such tests of arc welds, over 98% met the requirements.

Aside from the normalizing and testing requirements the new Code retains many of the provisions of the Code of 1926. There are a few exceptions. Materials not of established "weldable" quality may not be used until approved by the Welding Committee of the German Boiler Inspection Board. Welds that are machined must be marked so as to be recognized by inspectors. Welds should be avoided where considerable bending stresses occur. Fillet welds may be used for axial seams only in plates 0.39 inch thick or less, and for circumferential seams only in plates 0.59 inch thick or less. So far as possible fillet welds should be welded on both sides. Wall temperature over 350° C. should be avoided and drill holes or other openings should not be made in welds. The weld should be at a distance from the opening of at least 2 to 3 times the plate thickness.

# German Specifications for Welded Highway Bridges

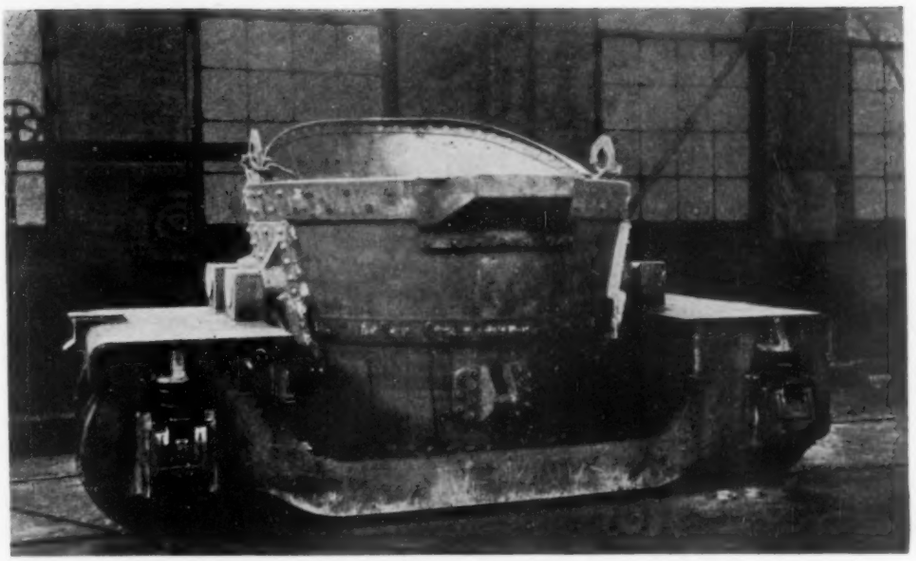
THE German Specifications for Welded Steel Plate Girder Highway Bridges (DIN 4101) adopted as standard this year are based on the Specifications for Welded Railway Bridges (DIN 4100) that appeared late in 1935. Although fatigue must be considered in the design of railway bridges, it need not be considered in the design of highway bridges. The Specifications consist of nine sections.

1. Purpose
2. Materials. Mild and low-alloy structural steels that are permissible for riveted construction are satisfactory for welding. Welding rod must pass the requirements of DIN 1913.
3. Arc (D.C. or A.C.), gas, arcogen and electric resistance processes may be used.
4. (a) Design of welds (same as DIN 4100). Prominence is given to the use of T bars and ribbed and nose-profile flanges.
   (b) Design of specific parts.
5. Design Stresses.

Design Stresses for Welds in Welded Highway Bridges, according to German Standard DIN 4101. The figures are the fraction of the permissible design stress for unwelded base metal.

| Weld | Load | Permissible Stress: Plain Carbon Steel | Permissible Stress: Low-Alloy Structural Steel | Remarks |
|---|---|---|---|---|
| Butt with perfect root penetration | tension | 0.8 | 0.8 | The basis is the design stresses of DIN 1073 for the material involved |
| | compression | 1.0 | 1.0 | |
| | shear | 0.65 | 0.65 | |
| Butt without perfect root penetration | tension | 0.72 | 0.65 | Minimum tensile strength of plain carbon steel = 53,000 psi; of low-alloy structural steel = 74,000 psi |
| | compression | 0.9 | 0.8 | |
| | shear | 0.55 | 0.50 | |
| End and Side Fillets | tension | 0.65 | 0.65 | |
| | compression | 0.65 | 0.65 | |
| | shear | 0.65 | 0.65 | |

6. Structural Details (stiffeners, angles of fillets, etc.).
7. Welding Procedure. The usual precautions, such as removal of rust, are repeated. The end fillets at the ends of flange plates in low-alloy structural steel carrying a tensile stress of 24,200 psi or over must be machined. If the flange plate is thicker than 1 inch it must be tapered (1 in 10) to a thickness of 1 inch at the ends. As much welding as possible should be done in the shop. In order to reduce shrinkage stresses, rigid welding should be avoided.
8. Inspection (Wedge and angle break tests).
9. Qualification of Welders, using the material to be welded. Test specimens are cruciform fillet tension specimen (0.47–0.59-inch plate), butt-weld tension specimen (0.39-inch plate), and roller-bend specimen (0.39-inch plate).



AN EXAMPLE OF OXYACETYLENE SHAPE-CUTTING MACHINE'S WORK

(All the body parts of this transfer car for molten metal, including the side frames, were cut to an exact fit by the machine and no machining was required before they were assembled by welding.)

# Recent Developments in Fusion Welding

By C. W. OBERT*

RESEARCH and scientific study have done much in recent years to advance the various welding processes. This has involved investigations of both the welding processes and the characteristics of the materials being joined or treated. Whereas in the early days of the welding art basic qualities of the material were often thought to be at fault, recent work has shown that either the welding process or the material could adversely affect the result. Improvements in welding processes have undoubtedly been more rapid than those in the materials, but now considerable is known about the characteristics of most of the weldable materials. In fact the importance of this phase of the subject has been recognized by the American Society for Testing Materials which has issued Standard Specifications A-151-35 covering the carbon steels that are known to be capable of being fusion welded satisfactorily. These general specifications exclude Bessemer steel material and all steel having a carbon content in excess of 0.35 per cent.

The article on Welding of Metals in the edition of the Metals Handbook that was published in 1936 by the American Society for Metals has classified the various metals with regard to their welding characteristics, including wrought and cast iron, wrought and cast steel, low- and high-alloy steels, stainless steel, copper and copper alloys, aluminum, and nickel and nickel alloys. Under each classification the metal is treated as broadly as possible with present data available, covering applications of all principal types of welding process. Data are recorded pertaining to desirable types of filler metal for each process, fluxing requirements, need for preheating or post heat-treatment, and desired manipulation of the welding process. While it is hoped that the data submitted have proved useful, it is recognized that they are as yet incomplete. The welding industry is being combed for further data to complete the records under certain classifications and to this end the assistance of the readers is solicited.

* Consulting Engineer, Union Carbide & Carbon Research Laboratories, New York, N. Y.

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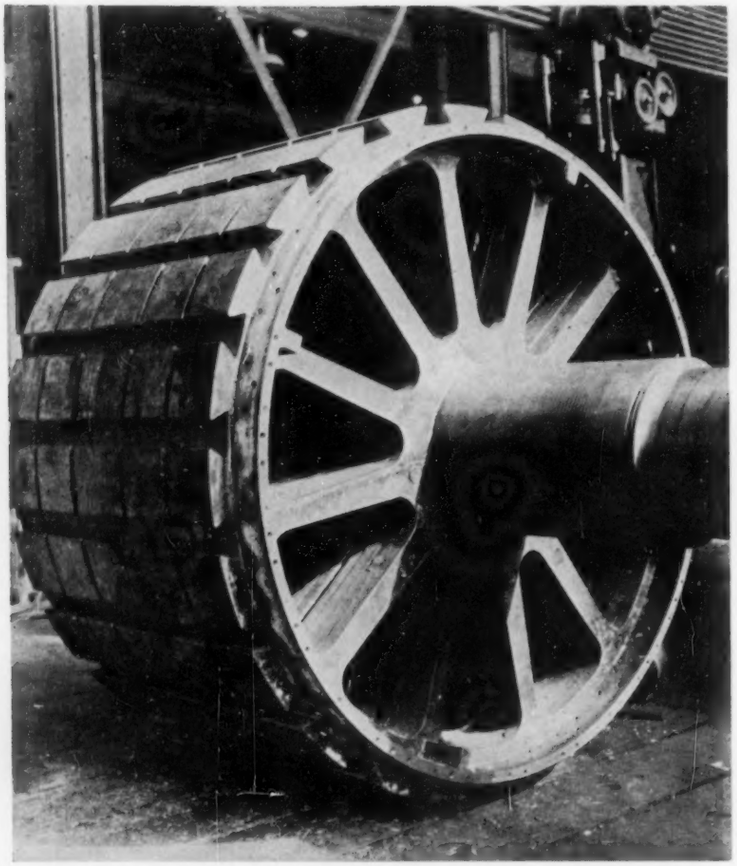
Type and cuts loaned through courtesy of Mechanical Engineering.

## FILLER METAL

The question of filler metal was at one time a serious consideration. At first the tendency was for welding fabricators to use any kind of wire or rod available, the assumption being that melting in the course of the welding process purified the weld metal sufficiently for the purpose. This view has, however, undergone a radical change and now definite specifications, not chemical but physical, governing the quality of the deposited weld metal are available. All chemical requirements are avoided because so many different compositions are capable of producing satisfactory welds if other features of the process application are properly manipulated. In other words, satisfactory welds cannot be obtained on the basis of chemical composition alone and demanding certain specific physical properties is now considered most effective, allowing the welding fabricator to utilize any means desired to obtain the required properties.

Tentative Specifications for Filler Metal issued last year by



THE OXYACETYLENE SHAPE-CUTTING MACHINE PRODUCED THESE IDENTICAL ROTOR SECTIONS

the American Welding Society exemplify this new idea by requiring welding rods and electrodes to be such that when deposited by any fusion-welding process in low-carbon commercial rolled plate certain tensile-test and bend-test requirements will be met. These requirements are divided into five groups as follows:

| Specification no. | Tensile strength, per cent of base metal | Bend elongation, per cent |
|---|---|---|
| 10 | 100 | 30 |
| 15 | 100 | 25 |
| 20 | 95 | 20 |
| 30 | 85 | 10 |
| 40 | 90 | 7 |

After approximately six years of experience with filler-metal specifications of this form in which all reference to chemical composition is avoided, satisfactory results have been obtained. With certain highly developed applications, deposited weld metal has been obtained which exceeds in quality the general average of rolled-steel plate, and all evidence points to the fact that the requirements in their present form have done much to raise the general standards of fusion welding.

### WELD QUALITY

For many years checking the quality of deposited weld metal without applying some destructive tests was considered impossible. This meant cutting a test sample out of the completed weld either in the form of a full-size test specimen or in the form of a diminutive specimen removed either by trepanning or slotting for etching and microscopic examination. This form of testing, while still used to some extent, was not sufficiently convenient or representative to inspire the confidence in welding that was desired and as a result certain nondestructive tests were established including X-ray and Gamma-ray examination, magnetic analysis, and sonic or stethoscopic testing. Of these the X-ray method of examination has been given the widest use and satisfactory results are obtained in determining the condition of welds on plate thicknesses up to more than 5 in. This method of process testing has been largely responsible for rapid advances in fusion welding for boiler drums and shells and for pressure vessels of all kinds. This art has developed to a point where, with proper technique, accurate and definite photographic views of the interior of welds may be obtained. Gamma-ray testing has been used only on special applications up to date.

Magnetic analysis has been used only to a limited extent for examination of deposited weld metal. It is useful for detecting cracks at or near the surface of the weld but it cannot be expected to give a complete indication of the condition of the interior in welds of considerable depth. The stethoscopic test has been used to some extent and results obtained tend to indicate that defects in welds can be located in plates of moderate thickness.

For the great majority of welding applied to structural steel, to machine frames, and for pressure vessels of less important classifications no nondestructive testing is required. For such welding applications the custom is to provide for testing the welding operators to make sure that they are properly qualified for the work they are expected to produce. Such operator qualification is usually based on tests of sample welds made by the operator with the process that is to be actually used. A number of different testing procedures have been devised for such qualification purposes, but recently the American Welding Society has issued a set of rules for both qualification of the process and testing of the welding operator which promises to meet the needs of the industry more satisfactorily than any of the former ones.

These new rules provide for testing the established process to make sure that it is adequate to meet all requirements for strength, shock, endurance, and similar properties, whereas the test procedure for checking the welding operator is only that necessary to prove that he can properly apply the established process. With this new set of rules satisfactory results have been obtained.

### STRESS RELIEVING

In the development of welded structures of all sorts warping troubles, deformations, and failures have led to the institution of numerous investigations which have proved that stresses locked up in the metal following the welding operation can be serious in character. It is generally considered impossible to avoid entirely such locked-up stresses although in the more ductile materials these shrinkage stresses are not found to be so serious in their results. In the higher-strength and less-ductile

materials it is generally considered to be desirable to subject the completed welded structure to some sort of a heat-treatment that will tend to relieve or at least minimize the intensity of the locked-up stresses.

The magnitude of locked-up stresses depends on several elements, such as number of welds, their position, and the welding technique employed. With some welding techniques these stresses can be greatly reduced. If they are not minimized in some manner results are likely to be objectionable, and to avoid this a form of heat-treatment known as "stress relieving" has been developed. This involves heating either the welded part or the entire welded assembly uniformly to a temperature between 1100 and 1200 F and holding this temperature for a period of time equivalent to one hour for each inch of thickness of the thickest part welded; the structure is then allowed to cool slowly under still-air conditions. This requirement which originated in the A.S.M.E. Boiler Construction Code has been applied with satisfactory results to all kinds and types of structure.

Where stress relieving an entire structure is impossible because of its form or size, provisions are made in most codes and specifications for stress relieving in sections. This is accomplished in the case of pressure vessels, piping, machine frames, and similar constructions by applying a furnace or other heating means locally to the region desired to be treated, heating the part covered to the temperature and under the same conditions as previously mentioned. In such cases it is generally considered desirable to heat the metal in a circular area around the welded portion for a distance of at least 12 times the thickness, the direction of heat application being away from the weld. In annular-ring welds the area to be heated should be at least six times the thickness of the metal wall measured along the pipe on either side of the weld. Under such conditions of application satisfactory results have been attained, but little experience has been obtained in application of the stress-relieving process to structural-welding work as applied in building or bridge structures.

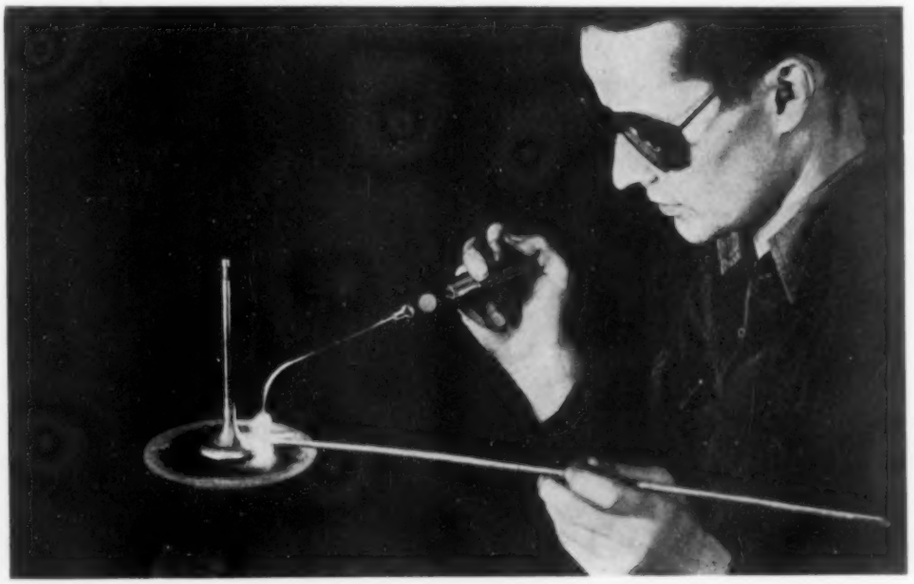
In this field of structural welding considerable research is being carried out not only to determine the actual need of stress relieving but also to devise ways of avoiding it where possible.

From what has been stated thus far in the paper it will be readily evident that the problems involved in application of fusion welding to the ordinary commercial grades of rolled and forged steel have been fairly well covered and that as a commercial fabricating process the welding art has been generally accepted in industry. When we wander outside of the range of the ordinary commercial grades of low-carbon steel and attempt to apply fusion welding to the alloy steels, cast iron, and certain of the nonferrous metals, problems of greater or less difficulty arise. In spite of the fact that much research work is underway, much work must still be done to bring this phase of the art down to a commercial basis. In the 1936 edition of the Metals Handbook the article on Welding of Metals contains a process chart and a descriptive outline that attempts to show the applicability of fusion welding to this wide range of metals, but the tabulation is conspicuous for its many gaps. These gaps are due, however, more to lack of knowledge than proved knowledge of inapplicability. This is the field where the greatest amount of investigation is needed and metallurgists can do more than any other group to solve these problems which are manifold in character because they involve in some cases the union of dissimilar metals. In fact the problem of joining dissimilar metals offers probably the greatest opportunities for investigation and development of any phase of metal fabrication.

In welding alloy steels a wide difference exists between the treatments to be accorded to high-alloy steels as compared with low alloy. In fact many of the latter have been found to be particularly well adapted for fusion-welding applications. These include the molybdenum and certain of the nickel-steel alloys. Those containing manganese, however, must be treated with care to avoid air hardening and formation of cracks. With the proper procedure and welding technique, however, strong, durable welds can be obtained in these steels.

The difficulties of welding high-alloy steels are generally increased in direct proportion to the complexity of the composition. Stainless steels have characteristic tendencies for precipitation of chromium carbide in the grain boundaries in the region adjoining the weld which causes susceptibility to intergranular corrosion which, of course, destroys the stainless characteristic. In the so-called 18–8 group of stainless steels stabilization by additions of columbium or titanium has the effect of greatly facilitating welding. In fact satisfactory procedures have been established for welding this stabilized material, as well as a series of proof tests to show the strength and inherent resistance of the weld zone against corrosion.

Satisfactory progress has been made in developing special procedures and techniques for welding cast iron over a wide range of variations in composition. Preheating is essential if the material is to be welded with filler metal closely resembling its own composition; only when a suitable nonferrous



AUTOMOTIVE VALVES LAST LONGER WHEN HARD-FACED

filler rod is used can preheating be avoided. In only a few applications can this material be welded satisfactorily without some form of heat-treatment.

Within the last few years many new compositions of alloy cast iron have come into use. For welding these much investigational work needs to be carried out. Without doubt satisfactory procedures can be established for most of these alloy compositions, but the thought is here proposed that if some investigative work is done alloy compositions might be developed that are especially suitable for fusion welding. Here is a fertile field for metallurgical work.

### APPLICATIONS OF NONFERROUS WELDING

One of the biggest opportunities in the wide field of nonferrous materials lies in the application of nonferrous welding to the joining of ferrous metals. Practically all nonferrous metals are well adapted to fusion-welding applications. Some of these, such as copper, require special treatment to reduce oxides that otherwise tend to segregate at the grain boundaries adjacent to the welds. In aluminum particularly the tendency to oxidize rapidly on the surface has caused difficulties in welding applications, but suitable fluxes have been developed which readily overcome this difficulty. When the wide range of nonferrous alloys is approached, complexities and difficulties magnify rapidly. In some cases each different composition requires special consideration to secure good results. Nickel alloys are, however, well-adapted to fusion welding.

REMOVING GATES AND RISERS FROM CASTINGS WITH AN OXYACETYLENE CUTTING BLOWPIPE

The most common application of nonferrous welding to the joining of nonferrous metals is what is known as "bronze welding." This is not a true fusion-welding process, as the metal parts to be welded are not actually melted but only heated to a point where "tinning" and amalgamation with the added bronze takes place. A highly satisfactory bond for many types of work is obtained in this manner. Often, as with cast iron, the joint between the metal and the bronze filler is stronger than the base metal itself. Recent investigations into the character of this bond have revealed that adherence of bronze to the base metal is a result of three effects, tinning, alloying, and intergranular penetration. The relatively low temperature required for bronze welding is responsible for greatly increased working speeds, and the property of bronze to yield readily as it cools reduces the possibility of locked-up stresses in welded castings.

A close second in this field is the process known as surfacing or facing which involves the application of nonferrous weld deposits to wearing parts of machinery to restore them to their original form. Application of certain types of wear-resistant material renders such wearing parts actually better than when they were new. The material most commonly used for this purpose is the group of bronzes that are so commonly used for antifriction bearings. These materials are readily applied to the worn wearing surfaces by certain welding processes and the deposits can then be machined to restore the wearing surfaces to their original dimensions.

Going a step farther in this direction we come to the large and attractive field of hard facings. In this a number of special alloys have been developed which are found to be exceptionally resistant to wear and abrasion. For these applications a relatively thin layer of one of these special materials is welded onto the worn wearing surface. The several different types of these materials can be applied for a number of different uses and are classified as follows:

(1) Cheap and short-lived alloys such as low-alloy cast iron and plain carbon steel.

(2) Alloy steels principally of an iron base with additions of chromium, tungsten, manganese, silicon, and carbon.

(3) True hard-facing alloys having compositions of from 50 to 80 per cent of iron with additions of one or more of the alloying elements used in (2) and sometimes small quantities of cobalt or nickel.

(4) True hard-facing alloys consisting principally of nonferrous alloys of cobalt, chromium, and tungsten.

(5) Carbide materials which are composed mostly of tungsten-carbide particles with small percentages of ductile metals for binders.

(6) Crushed tungsten-carbide fragments made available for welding by fusing to a strip of metal or combined with other hard-facing alloys in welding rod.

This group of surfacing materials offers great promise for future development as these facings can be applied to protect the surfaces in machines that receive the greatest wear which permits utilization of cheaper material for the rest of the machine or part. The hard facing keeps the wearing parts in efficient condition much longer and not only decreases power requirements, but also avoids shutdowns.

From the outline that has been given many features of the fusion-welding art will be observed to be of prime interest to the metallurgist and are in fact inherently a part of his field.

Development of different types of filler metal would appear to depend upon the skill of the metallurgist, and above all development of base-metal modifications to render them more suitable for fusion welding is a great opportunity for the metallurgist. With the intelligent guidance of capable scientists the art of fusion welding has undoubtedly a broad and promising future.

# CURRENT WELDING LITERATURE

Building Codes. New York's New Building Code Recognizes Structural Welding. Welding Engr. (Aug. 1937), vol. 22, no. 8, pp. 27–29.

Cars, Freight. Hopper Car Construction Simplified by Welding. A. F. Davis. Iron Age (July 22, 1937), vol. 140, no. 4, pp. 51–52 and 123.

Chimneys. 124-Ton Steel Stack Uses Unique Construction Principles. Welding Engr. (Aug. 1937), vol. 22, no. 8, pp. 20–23.

Chimneys. Largest Welded Stack at Fisk Station. Power (Sept. 1937), vol. 81, no. 9, pp. 507–508.

Electric Arc Welding, P. J. Risdon. Elec. Welding (Aug. 1937), vol. 6, no. 36, pp. 197–202. Comparative costs of welded and riveted structures; electric welding in Germany; welding *vs.* steel castings; economy increases with span.

Electric Welding Machines. Electric Arc Solves Rail Maintenance, J. L. Brown. Elec. J. (Sept. 1937), vol. 34, no. 9, pp. 357–360.

Electric Welding Machines. Mechanical High-Speed Resistance-Welder Control, F. H. Roby. Elec. Eng. (Sept. 1937), vol. 56, no. 9, pp. 1145–1148.

Electric Welding, Resistance. Suggestions for Improving Quality of Resistance Welds, A. M. MacFarland. Welding Engr. (Aug. 1937), vol. 22, no. 8, pp. 17–19.

Electric Welding, Resistance. Electric Spot Welding at Doncaster Works, L.N.E.R. Ry. Gaz. (Sept. 17, 1937), vol. 67, no. 12, p. 473.

Machinery Manufacture. Machine Housings Welded to Close Limits, F. J. Oliver. Iron Age (July 8, 1937), vol. 140, no. 2, pp. 38–41.

Natural Gas Pipe Lines. Interesting Pipe Procedure Used on Recently Completed Line. Gas Age-Rec. (Apr. 29, 1937), vol. 79, no. 9, pp. 35–36.

Oil Wells. Welding of Oil-Well Casing, L. R. Hodell. Min. & Met. (Aug. 1937), vol. 18, no. 368, pp. 380–382.

Oxyacetylene Cutting. Flame Cutting—I and II, P. Ross. Welding Engr. (July 1937), vol. 22, no. 7, pp. 20–22 and (Aug.), pp. 31–33.

Oxyacetylene Welding. Rightward Method of Oxy-Acetylene Welding. Engineering (July 16, 1937), vol. 144, no. 3731, p. 84. With this method blowpipe is moved from left to right and followed, not preceded, by welding rod; advantages pointed out.

Oxyacetylene Welding. Use of Oxy-Acetylene Process in Coal Mining Industry, G. S. Jenkins. Min. Congress J. (Mar. 1937), vol. 23, no. 3, pp. 34–35 and 37.

Oxyacetylene Welding Practices in Metal Mining Industry, H. R. Wass. Min. Congress J. (May 1937), vol. 23, no. 5, pp. 89–90.

Petroleum Refineries. Repairing Refinery Pumps by Welding, C. H. S. Tupholme. Petroleum Times (Aug. 14, 1937), vol. 23, no. 970, pp. 203–204.

Pipe Lines. Pipe-Welding by Multi-Flame Method. Engineering (July 23, 1937), vol. 144, no. 3732, p. 107.

Railroad Engineering. International Railway Congress. Engineer (June 25, 1937), vol. 163, no. 4250, pp. 722–725. Brief account of Paris meeting opened May 31st; visits and inspections; review of reports and discussions on strengthening track for high speeds; welding of rails and crossings.

Rails. Electric Machine Welding of Rails. Commonwealth Engr. (Dec. 1, 1936), vol. 24, no. 5, pp. 179–180.

Rails, Electric Welding. Welding Bull-Head Rails by Katona Method. Ry. Gaz. (Sept. 10, 1937), vol. 67, no. 11, pp. 441–442.

Rails. 30 More Miles of Welded Track. Ry. Eng. & Maintenance (Sept. 1937), vol. 33, no. 9, pp. 596–600 and 612; see also Ry. Age (Sept. 4, 1937), vol. 103, no. 10, pp. 300–302 and 310–311; Ry. Elec. Engr. (Sept. 1937), vol. 28, no. 9, pp. 211–213.

Sand and Gravel Plants. Hard Surfacing Beats Sand and Stone, O. E. Perkins. Industry & Welding (June 1937), vol. 10, no. 6, pp. 25–26 and 29.

Shearing Machine. Plate-Frame Punching and Shearing Machine. Engineering (June 25, 1937), vol. 143, no. 3728, p. 733.

Shipbuilding. Arc-Welded Construction Increases Capacity of Freighters, A. F. Davis. Welding Engr. (July 1937), vol. 22, no. 7, pp. 29–32.

Shipbuilding. Welding Developments in Shipbuilding, W. D. Strathdee. Mar. Eng. & Shipg. Rev. (July 1937), vol. 42, no. 7, pp. 370–371.

Stainless Steel, Welding. A. E. Taylor. Product Eng. (Oct. 1937), vol. 8, no. 10, pp. 399–401.

Steam Power Plants. Welding at Waterside, W. S. Morrison and W. J. Angus. Power (Sept. 1937), vol. 81, no. 9, pp. 480–483.

Steam Turbines. Arc-Welded Marine Machinery, R. F. Wyer. Mar. Eng. & Shipg. Rev. (July 1937), vol. 42, no. 7, pp. 390–382.

Steel Castings. New Outlets for Steel Castings, R. Lemoine. Foundry Trade J. (Aug. 12, 1937), vol. 57, no. 1095, p. 130.

Steel Fatigue. Effect of Overload on Fatigue Properties of Several Steels at Various Low Temperatures, H. B. Wishart and S. W. Lyon. Am. Soc. Metals. Trans. (Sept. 1937), vol. 25, no. 3, pp. 690–698 and (discussion), 699–701.

Steel Hardening. Surface Hardening by Acetylene-Oxygen Flame, W. Eberle. Eng. Progress (Sept. 1937), vol. 18, no. 9, pp. 205–208.

Steel Plates. Determination of Residual Strains and Stresses in Arc-Welded Plates, H. E. L. Martin. North-East Coast Instn. Engrs. & Shipbldrs. Trans., vol. 53, 1936–37, pp. 255–281, and (discussion), D143–164.

Structural Steel. Present Status of Electric Welding in Steel Building Construction, G. Fish. Elec. News (Sept. 1, 1937), vol. 46, no. 17, p. 27.

Structural Welding, O. Bondy. Civ. Eng. (Lond.), vol. 32, no. 367 (Jan. 1937), pp. 9–13 and (Feb.), no. 368, pp. 67–71. Jan.: Study of German practice; permissible working stresses in butt welds; welding procedure; welding machines and electrodes; X-ray testing; rotary jigs for welding of big plate girders. Feb.: Stress distribution; economical design; British practice; cutting and welding; need for centralization; design for site welding.

Structural Steel. Welding for New York Buildings, G. D. Fish. Eng. News-Rec. (Sept. 23, 1937), vol. 119, no. 13, pp. 509–512.

Swimming Pools. Welded Structure for Thornaby Baths. Engineer (July 30, 1937), vol. 164, no. 4255, p. 125. Brief illustrated description of structural framework of new swimming baths; building has total length of 121 ft. and span of 54 ft.

Telescopes. 200-In. Telescope, World's Largest, Has Mounting of Welded Steel, G. H. Froebel. Metal Progress (Aug. 1937), vol. 32, no. 2, pp. 132–137.

Training. Preparing General Training Course for Welding Operators. Can. Machy. (Dec. 1936), vol. 47, no. 12, pp. 179–180, 182, 184, 186, 188 and 192.

Tubes. Bending Strength of Thin-Walled Cylindrical Tubes, K. E. Hansen. Copenhagen Roy. Tech. College—Structural Research Laboratory—Report, no. 9, 1937.

Tubes. Steel Tube Joints. Product Eng. (Oct. 1937), vol. 8, no. 10, pp. 396–398.

Tubes. Steel Tube Construction. Product Eng. (Sept. 1937), vol. 8, no. 9, pp. 357–359.

Tubes. Steel Tubing Made by Resistance Welding, C. O. Herb. Machy. (N. Y.), vol. 44, no. 1 (Sept. 1937), pp. 1–5.

Warehouses. Welded Structural Steel Warehouse. Engineering (May 28, 1937), vol. 143, no. 3724, pp. 623–624.

Welded Steel Structures. Residual Stress, W. C. Stewart. Am. Soc. Naval Engrs. J. (Aug. 1937), vol. 49, no. 3, pp. 307–323.

Welded Steel Structures. Welded Diagrid Steel Structures, St. Szegoe. Elec. Welding (Aug. 1937), vol. 6, no. 36, pp. 174–195.

Welding. Organizing Shop for Production Welding, E. C. Breckelbaum. Welding Engr. (Aug. 1937), vol. 22, no. 8, pp. 24–25.

Welding Machines. New Method of Mechanical High-Speed Resistance-Welder Control, F. H. Roby. Elec. News (Sept. 15, 1937), vol. 46, no. 18, pp. 35–38.

Welding Rods. Welding and Welding Rods, J. Sack. Philips Tech. Rev. (May 1937), vol. 2, no. 5, pp. 129–135.

Welds. Welding Design, C. H. Jennings. Am. Soc. Mech. Engrs.—Trans. (July 1937), vol. 59, no. 5, sec. 1, pp. 462–465.

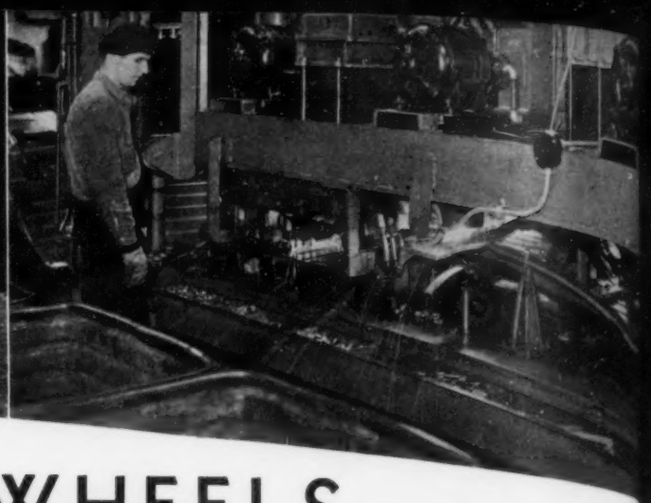
Welds, Properties. Thermal Influences—How They Affect Weld Metal, B. Ronay. Welding Engr. (July 1937), vol. 22, no. 7, pp. 17–19.

Wire Employed in Dentistry, E. W. Skinner. Wire & Wire Products (Sept. 1937), vol. 12, no. 9, pp. 465–468 and 496–498.

Wrought Iron, Welding. Mar. Eng. & Shipg. Rev. (July 1937), vol. 42, no. 7, pp. 377–379.

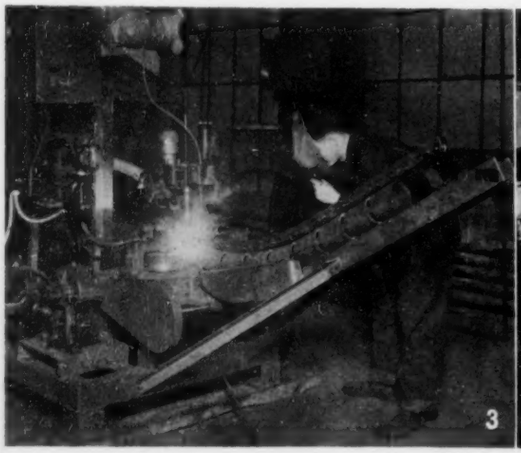
GET YOUR MEMBER!

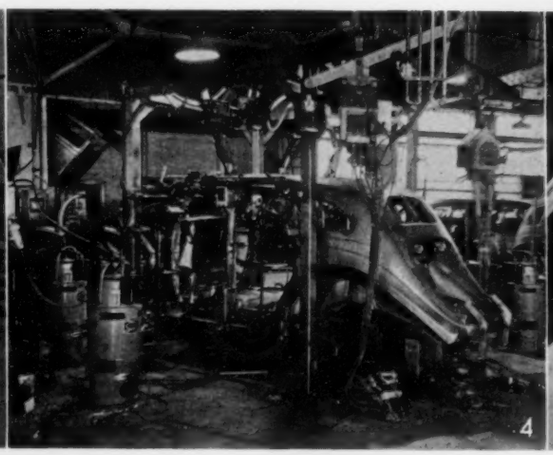
Members joining on or before NOVEMBER 15th will have their names included in the YEAR BOOK



# WELDING ON WHEELS

**In the construction of the 5,102,000 passenger cars and trucks sold of the 1937 models welding was used to greater extent than ever before.**





1. Chrysler Royal 4-Door Touring Sedan, 119-Inch Wheelbase, 95 Hp.

2. To Complete the Steel Floor of a Chrysler Royal and Give It Greatest Strength and Rigidity, Some 20 Braces and Supports Are Placed in This Massive New Hydromatic Welding Machine and the Operator Throws the Switch and One Hundred and Sixty-Four Points Are Welded in 16 Seconds

3. Fabricating Automobile Starter Frames by Automatic Shielded Arc Welding. Courtesy Lincoln Electric Co.

4. Arc Welding Nash Bodies in the Seaman Body Plant. Courtesy Harnischfeger Corp.

5. The Oxyacetylene Blowpipe Is Indispensable for Fabricating the All-Steel Bodies of Plymouth Cars. Courtesy The Linde Air Products Company

6. Parts for Spare Tire Racks on Special Trucks Are Easily Shaped by the Oxyacetylene Cutting Machine. Courtesy The Linde Air Products Co.

7. A Thorough Welding Job—This Complex Appearing Machine in the Body Plant of the Hudson Motor Car Co. In Detroit Welds the Wheel Housing and Quarter Panel Hydromatically. Sparks Fly When the Operator Pushes the Lever, but When the Job Is Done the Sections Are as Solid as One Piece. The Sheet Steel Parts Are Placed in the Machine, a Lever Pressed, and the Welding Points Come Down in Exactly the Correct Place

8. Butt or Flash Welding of the Muffler to the Exhaust Pipe of Ford Car.

9. Modern Hydrometer Welding Equipment Is Used Extensively in Building the New Chrysler Royal or Imperial Safety Steel Bodies

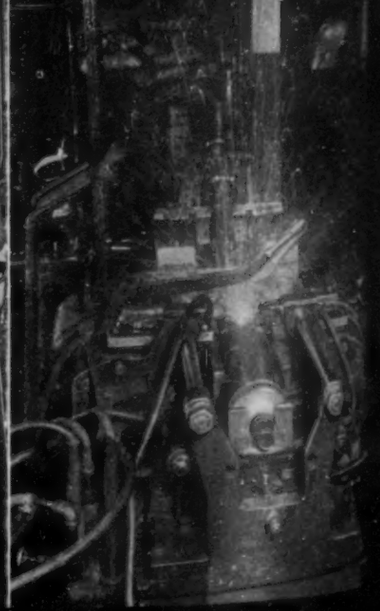
10. The Automotive Industry Speeds Production and Cuts Costs with Automatic Arc Welding. Shown Here Is a Battery of Automatic Carbon Arc Welders for Fabricating Oldsmobile Rear Axle Housings. Courtesy The Lincoln Electric Co.

11. Seam Welding the Halves of the Gas Tank Together Using the "Iron Man." Courtesy Ford Motor Company

12. Flash Welding Operation on Automobile Cowl and Windshield Assembly. Courtesy P. R. Mallory & Co.

13. Spot Welding Cab of One of America's Leading Trucks. Courtesy P. R. Mallory & Co.

14. Fleet of Finished Auto Carriers Fabricated by Whitney and Kales Co. Courtesy Champion Rivet Company



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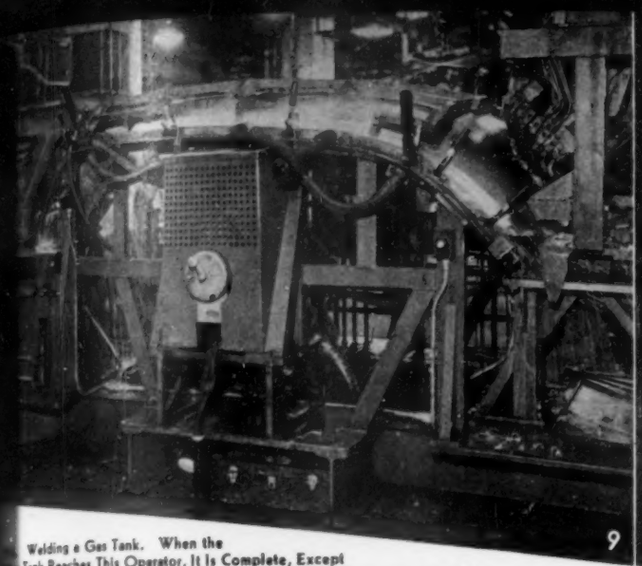

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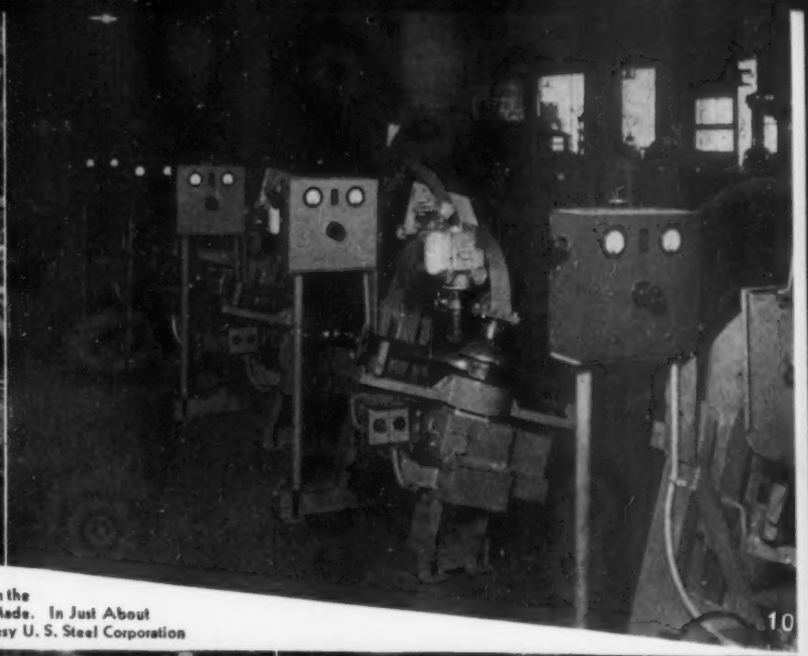
Welding a Gas Tank. When the
Tank Reaches This Operator, It Is Complete, Except
It Is Open at the Top. This Machine Welds This Seam and Turns the
Out Complete. The Tank Is Shown Just as the Operator Is Placing It in the Machine. When the
Is Moved, Placing the Machine in Operation, Sparks Fly as the Electrical Connection Is Made. In Just About
Seconds, the Operation Is Complete. The Photo Was Taken at the Hudson Plant. Courtesy U. S. Steel Corporation



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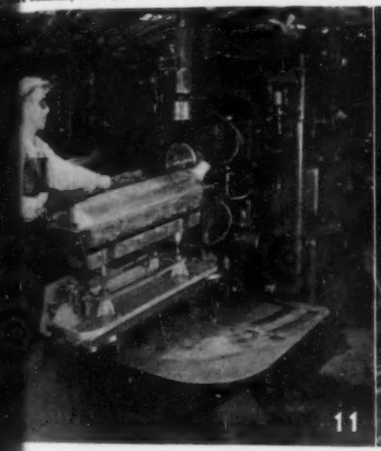

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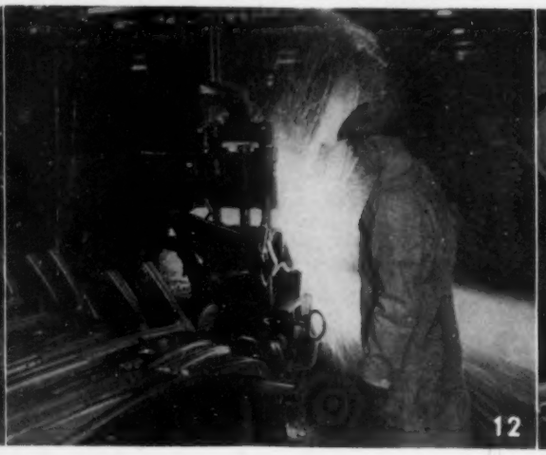

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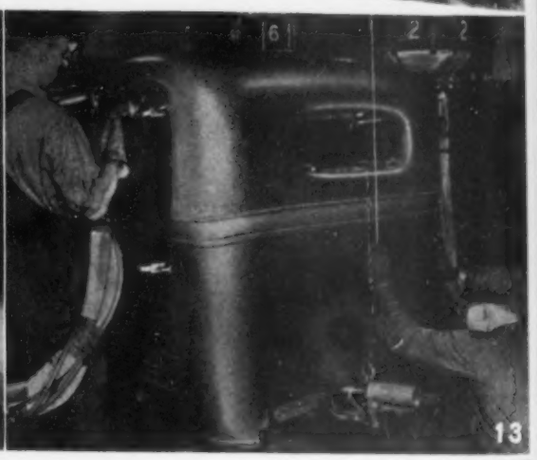

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Inside View of Auto Carrier Shown in Fig. 14

Multiple Spot Welding of Door Panel to Frame. Courtesy Ford Motor Co.

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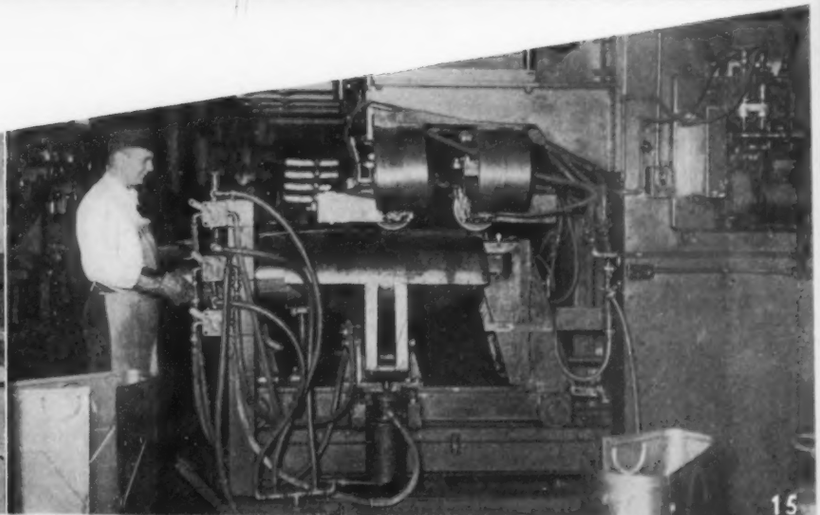

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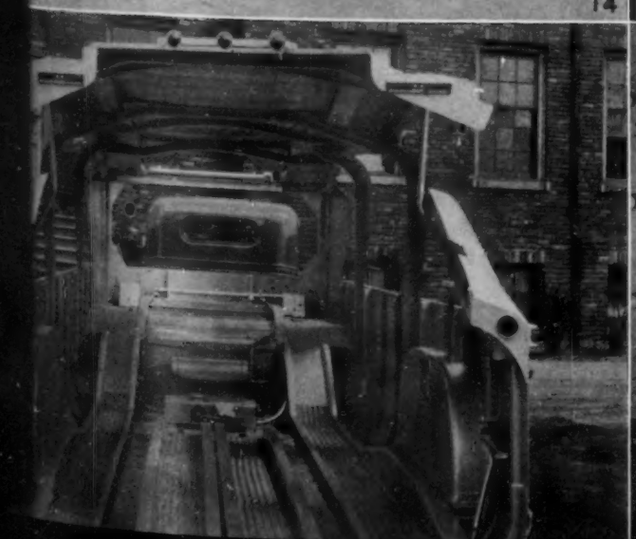

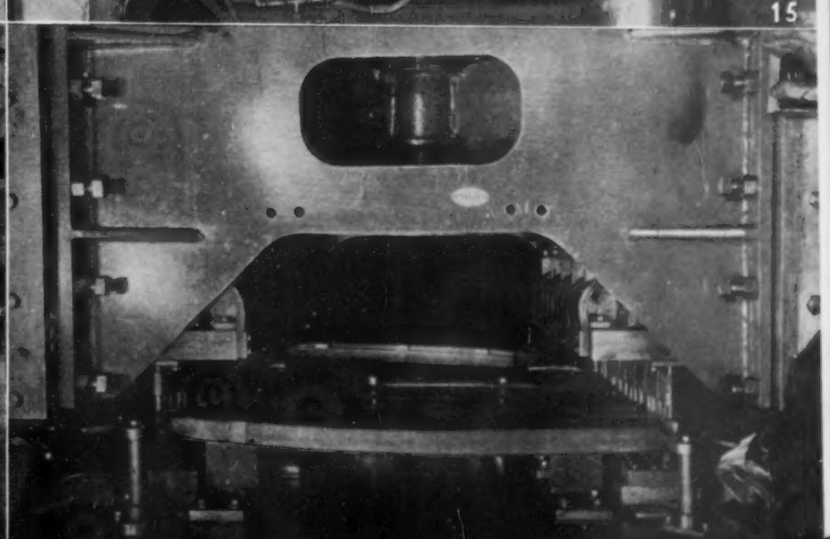

# CHAIRMEN AND SECRETARIES OF SECTIONS AND REGULAR MEETING DATES

To Members
AMERICAN WELDING SOCIETY

When in any city where sections of the Society are located—try to attend the meetings if held during your visit. This will widen your contacts in welding and enable you to interchange experience with others in similar lines of business. If no regular meeting date is given telephone the Secretary and he will gladly tell you.

**BIRMINGHAM** — 3rd Fri.
CHAIRMAN—E. E. MICHAELS, Chicago Bridge & Iron Co., P. O. Box 277
SECRETARY—J. E. DURSTINE, Lincoln Elec. Co., 505 No. 22nd St.

**BOSTON** — 3rd Fri.
CHAIRMAN—P. J. HORGAN, General Electric Co., Lynn, Mass.
SECRETARY—P. N. Rugg, Boston Edison Co., 39 Boylston St.

**CHICAGO** — Last Fri.
CHAIRMAN—TOM JONES, 8244 East End Ave.
SECRETARY—L. C. Monroe (Webster 7134), The Welding Engineer, 608 So. Dearborn Street.

**CLEVELAND** — 2nd Wed.
CHAIRMAN—E. R. BENEDICT, Contract Welders, Inc., 2445 E. 79th Street
SECRETARY—E. T. SCOTT, Cleveland School of Welding, 2261 E. 14th St.

**DETROIT** — 1st or 2nd Fri.
CHAIRMAN—VAUGHAN REID, City Pattern Works, 1165 Harper Ave.
SECRETARY—H. P. DOUD, General Electric Company, 700 Antoinette St.

**HAWAII**
CHAIRMAN—E. E. HEACOCK, Hawaiian Gas Products Ltd., P. O. Box 2454, Honolulu, T. H.
SECRETARY—R. L. MULLEN, Honolulu Iron Works Co., Honolulu, T. H.

**KANSAS CITY** — 3rd Mon.
CHAIRMAN—C. E. WOODMAN, Kansas City Bridge Co., 215 Pershing Rd.
SECRETARY—ALBERT W. ROTH, 1531 Broadway

**LOS ANGELES** — 3rd Thurs.
CHAIRMAN—WAYNE A. HOWARD, General Petroleum Corp., 2525 E. 37th Street
SECRETARY—J. C. GOWING, P. O. Box 186, Huntington Park, Calif.

**MARYLAND** — 3rd Fri. except April
CHAIRMAN—DR. J. W. MILLER, Reid Avery Co., Ches. & Cleveland Aves., Dundalk, Md.
SECRETARY—C. N. HILBINGER, Lincoln Electric Company, Baltimore, Md.

**MILWAUKEE** — 2nd Wed.
CHAIRMAN—K. L. HANSEN, Harnischfeger Corp.
SECRETARY—J. J. CHYLE, 2841 N. 51st St.

**MONTANA** — 1st Wed.
CHAIRMAN—HENRY F. C. RUMFELT, 701 Musselshell, Fort Peck
SECRETARY—ALLEN W. BATES, Apt. 4503D, Fort Peck, Montana

**NEW YORK**
2nd Tues. except when Joint Meeting is held
CHAIRMAN—R. W. BOGGS, The Linde Air Products Co., 205 E. 42nd St.
SECRETARY—MILTON MALE, U. S. Steel Corp., 71 Broadway

**NORTHWEST & ST. PAUL (Minneapolis)** — 3rd Wed.
CHAIRMAN—H. J. KICHERER, American Hoist & Derrick Co., St. Paul, Minn.
SECRETARY—ALEXIS CASWELL, Manufacturers Assoc. of Minn., 405 Marquette Ave.

**NORTHERN N. Y.** — Last Thurs.
CHAIRMAN—W. F. HESS, Rensselaer Polytechnic Inst., Troy, N. Y.
SECRETARY—G. A. ROSS, General Electric Co., Schenectady, N. Y.

**WESTERN N. Y.** — 3rd Fri.
SECRETARY—H. J. SCHLEIDER, Air Reduction Sales, 730 Grant St., Buffalo, N. Y.

**OKLAHOMA CITY**
CHAIRMAN—O. T. BARNETT, Black, Sivalls & Bryson, Inc., Box No. 1377, Okla. City, Okla.
SECRETARY—K. B. BANKS, P. O. Box 1377, Okla. City, Okla

**PHILADELPHIA** — Middle Mon.
CHAIRMAN—T. M. JACKSON, Sun Shipbuilding & D. D. Co., Chester, Pa.
SECRETARY—H. E. HOPKINS, Arcos Inc., 401 N. Broad St.

**PITTSBURGH** — Middle Wed.
CHAIRMAN—LEON C. BIBBER, Carnegie-Illinois Steel Corp., Carnegie Building.
SECRETARY—J. F. MINNOTTE, Minnotte Bros., 1201 House Bldg.

**PORTLAND**
CHAIRMAN—G. C. DIERKING, Steel Tank & Pipe Co., P. O. Box 1899, Sta. F
SECRETARY—L. M. PICKETT, Steel Tank & Pipe Co., P. O. Box 1899, Sta. F

**SAN FRANCISCO** — Last Fri.
CHAIRMAN—N. F. WARD, University of Calif., Berkley, Calif.
SECRETARY, J. G. BOLLINGER, Air Reduction Sales, Park & Halleck Sts., Emeryville, Calif.

**ST. LOUIS** — 2nd Fri
CHAIRMAN—A. W. HARRIS, 2449 Milk Avenue, Alton, Ill.
SECRETARY—C. W. S. SAMMELMAN, 4359 Lindell Blvd.

**YOUNGSTOWN (Ohio)**
CHAIRMAN—CHARLES WATSON, Youngstown Welding & Engr. Co.
SECRETARY—C. A. WILLS, Wm. R. Pollock Co., Youngstown, Ohio.

**SOUTH TEXAS**
CHAIRMAN—MARVIN COOK, Humble Oil & Refining Co., Houston
SECRETARY-TREAS.—MALCOLM V. REED, P. O. Box 3052, Houston

**WASHINGTON**
CHAIRMAN—A. G. BISSELL, Bureau of Construction and Repair, Navy Dept., Washington, D. C.
SECRETARY—C. A. LOOMIS, Bureau of Construction & Repair, Navy Dept., Washington, D. C.

## SECTIONS BEING DEVELOPED

There is shown below Sections in process of organization and the name of the contact man in each locality. This contact man is either Chairman or Secretary of an active group interested in the formation and completion of Section Organization. Those members desiring to assist should communicate with these individuals.

**ATLANTA, GA.**
M. C. SNEAD, Link Belt Company, 1116 Murphy Avenue, S. W.

**CANTON, OHIO (Akron, Alliance, etc.)**
ROBERT M. WALLACE, The Griscom-Russell Company, Massillon, Ohio

**CHATTANOOGA, TENN.**
CHESTER T. RAYMO, Chattanooga Boiler & Tank Company, 1030 East Main St., Chattanooga

**CINCINNATI, OHIO**
W. W. PETRY, Cincinnati Milling Machine Co., Cincinnati, Ohio

**COLORADO**
J. H. JOHNSON, Intermountain Belting & Packing Co., Denver, Col.

**COLUMBUS, OHIO**
PROF. O. D. RICKLY, Ohio State University

**MIAMI VALLEY (Dayton, Troy, etc.)**
E. STANSEL, Frigidaire Division, General Motors Corp., Dayton, Ohio

**DALLAS-FORT WORTH, TEXAS**
E. E. DILLMAN, Wyatt Metal & Boiler Works, Dallas, Texas

**FORT WAYNE, INDIANA**
JAMES MCCLURE, Wayne Welding Supply Co., 513 East Wayne St., Fort Wayne, Indiana

**INDIANAPOLIS, INDIANA**
W. R. GARTEN, Sutton-Garten Company, 401 West Vermont St.

**LOUISVILLE, KY.**
A. HURTGEN, Henry Vogt Machine Company, 10th & Ormsby Streets

**MEMPHIS, TENN.**
B. B. DRURY, JR., Modern Engineering Company, 238 South Front St.

**NEW ORLEANS, LA.**
A. H. GUILLOT, New Orleans Public Service Company, 317 Baronne St.

**OMAHA, NEBRASKA**
L. O. SCHNEIDERWIND, Omaha Welding Company, 1501 Jackson Street

**ROCHESTER, N. Y.**
THOS. S. GAYLORD, Eastman Kodak Co.

**TOLEDO, OHIO**
J. W. SHUGARS, The Lincoln Electric Company, 632 Spitzer Building

**TULSA, OKLAHOMA**
R. R. THOMPSON, Air Reduction Sales Company, Tulsa, Oklahoma

**WICHITA, KANSAS**
R. L. TOWNSEND, Phillips & Easton Supply Co.

# WELDING SOCIETY ACTIVITIES
## AND RELATED EVENTS

### Newly Elected Officers

*President*—P. G. Lang, Jr., Engineer of Bridges, The Baltimore & Ohio Railroad, Baltimore, Maryland.

*Senior Vice-President*—G. F. Jenks, Chief of Technical Staff, Ordnance Dept., United States Army, Washington, D. C.

*Southern Divisional Vice-President*—W. J. Sanneman, Service Metallurgist, Tennessee Coal, Iron & Railroad Co., Birmingham, Alabama.

*Pacific Coast Divisional Vice-President*—K. V. King, Engineer, Standard Oil Company, San Francisco, Calif.

*Directors at Large:*

A. M. Candy, Hollup Corporation, Chicago, Illinois.

J. H. Deppeler, Chief Engineer, Metal & Thermit Corporation, New York, N. Y.

A. E. Gaynor, J. A. Roebling Sons Company, New York, N. Y.

E. R. Fish, Mechanical Engineer, The Hartford Steam Boiler Inspection & Insurance Co., Hartford, Conn.

L. S. Moisseiff, Consulting Engineer, New York, N. Y.

### Philip George Lang, Jr.
### Newly Elected President—
### AMERICAN WELDING SOCIETY

Mr. Lang was born in Philadelphia on September 24, 1883. He received his Bachelor and Master Degree in Civil Engineering from the University of Pennsylvania. Phil Lang devoted his summers, while attending college, as draftsman and surveyor. He joined the American Bridge Company upon graduation in 1905 and stayed with them for about one year. He then accepted the position as Designer for the South & Western Railroad (now C. C. & O.), and late in 1907, became Assistant Engineer for the Baltimore and Ohio Railroad. On May 1, 1917, he became Chief Bridge Draftsman of the same railroad and on August 1, 1918, Assistant Engineer of Bridges. In May 1921 he became Engineer of Bridges, which position he holds at the present time. Among the large projects which Mr. Lang supervised are:

Allegheny River Bridge, Pittsburgh, Pa. Reconstruction of large railroad bridge on old alignment, at elevation 15 ft. above old structure, involving complex jacking and rolling operations.

Great Miami River Bridge, Lawrenceburg, Ind.

Little Kanawha River Bridge, Parkersburg, W. Va.

Chicago River Bridge, Chicago, Ill.
Design and construction of large bascule bridge at old grade—subsequently raising to new grade by novel jacking operation, rarely undertaken, especially for bascule bridges. Raise in this case 12 ft.

Mechanical Trimmers on Curtis Bay Coal Pier, Baltimore, Md.
Design, construction and installation of World's first practicable device for the trimming or stowing of bulk material in the cargo space of vessels.

Mr. Lang has contributed some sixty articles and papers to the publication of

Philip George Lang, Jr.

technical bodies and professional periodicals. A few of these are:

"Mechanical Trimmers Solve Ship Loading Problem"—*Engineering News Record*, August 26, 1920.

"The Reconstruction of the Baltimore and Ohio Railroad Bridge Crossing the Allegheny River, at Pittsburgh, Pa."—*Proc. A. S. C. E.*, April 1922.

"Bridge Section," *Railway Engineering and Maintenance Cyclopedia*—Simmons-Boardman Publishing Co., Editions of 1926 and 1929.

Report for America on "Static and Dynamic Stresses in Railway Bridges"—International Railway Congress, 1930 Session, Madrid, Spain.

"Jacks Raise 3300-ton Bridge 11½ Feet to New Grade"—*Construction Methods*, September 1931.

"Ninety-Four Years of Bridges at Harpers Ferry"—*Engineering News Record*, September 17, 1931.

"Fusion Welding of Bridges"—THE WELDING JOURNAL, April 1936.

Mr. Lang is a member of a number of societies, including American Society for Civil Engineers, American Railway Engineering Association, American Standards Association, AMERICAN WELDING SOCIETY, Association of American Railroads and the Engineers' Club of Baltimore. He is active on many of the committees of these organizations, being a member of some seven such committees and chairman of two others. In addition to being President of the AMERICAN WELDING SOCIETY, he is also now President of the Engineers' Club of Baltimore.

His hobby is golf.

Members of the AMERICAN WELDING SOCIETY best know Mr. Lang through his work as Chairman of the Committee on Bridges, which formulated Specifications for the Design, Construction, Alternation and Repair of Highway & Railway Bridges by Fusion Welding, which was published as a code by the Society in 1936 and which has been adopted or endorsed by the American Railway Engineering Association and the American Association of State Highway Officials.

Mr. Lang brings to the AMERICAN WELDING SOCIETY a wealth of experience in the operation of technical societies and committees and we can look forward with a reasonable expectation of the continued growth of the AMERICAN WELDING SOCIETY and the maintenance of its prestige as the world's leading engineering and scientific organization devoted to the interest of welding.

## Eighteenth Annual Meeting American Welding Society

The 18th Annual Meeting and Welding and Cutting Exposition of the AMERICAN WELDING SOCIETY held in Atlantic City, October 17th to 22nd, inclusive, was characterized by all as being one of the most successful ever held by the Society.

The registration totaled about the same as last year, namely, around a thousand. On the other hand, the character of the papers, the type of attendance, the number of welding displays at the exposition surpassed anything in the history of the Society.

It would be impossible to indicate by name all of the many members of the Society who were responsible for the success of this meeting. The official program alone includes the names of nearly a hundred individuals who served on one or more committees or presented papers. Special credit is due to the Philadelphia and Maryland Sections of the Society for the smoothness of operation and the arrangements for the well-being of those who attended. Among those committees which should receive honorable mention are those relating to Convention, Technical Program, Entertainment, Reception, Registration and Exposition (Manufacturers).

The meeting started off with an informal President's reception Sunday Afternoon and Evening. A candid cameraman's story of this particular session is given on page 2.

Altogether there were some 34 technical papers presented dealing with a variety of subjects. Other special features, in addition to the exposition, included numerous committee meetings, a research conference on Tuesday evening and the annual banquet and dance of the Society Thursday evening.

Special guest speakers, included, on Monday Morning, Mr. E. G. Budd, President of the Edward G. Budd Manufacturing Co., and on Wednesday Morning, The Honorable Harold G. Hoffman, Governor of the State of New Jersey.

This is one occasion where the ladies enjoyed the meeting as much as their men folks. Scheduled events included the President's reception, luncheon and style show, motor trip and tea at country club, card party, fortune teller and visit to Net Haul.

Special credit is due to the Philadelphia Section for the arrangements in connection with the annual banquet and the entertainment. The singing furnished by a local Philadelphia club of business girls was an unusual treat as was, also, a highly scientific(?) talk by Dr. S. I. McPherson, reproduced elsewhere in this Journal. He was ably assisted by Mr. F. T. Llewellyn, past-president of the Society.

All in all, the Annual Meeting was an unusual success.

## T. M. Jackson Wins Lincoln Medal

The first Lincoln Gold Medal was awarded at the Atlantic City Convention of the AMERICAN WELDING SOCIETY to Mr. T. M. Jackson, Chief Electrical and Welding Engineer of the Sun Shipbuilding and Dry Dock Co., for the best paper of the year presented before a Section or National meeting and published in THE WELDING JOURNAL which contributed to the advancement of welding.

Mr. Jackson is a graduate of Cornell University and has been employed with the Sun Shipbuilding Company for about nineteen years. Previous to entering the employ of the Sun Company he was connected with the Westinghouse Elec. & Mfg. Co.

Chairman Jenks Presents the Lincoln Medal to Mr. Jackson

This paper entitled "Welding in Tanker Construction" was published in the October 1937 issue of THE WELDING JOURNAL and presented before the Shipbuilding Session of the Annual Meeting of the Society on Thursday Afternoon, October 21st.

## President Lang's Address*

Mr. President, Honored Guests, Ladies and Gentlemen:

THE AMERICAN WELDING SOCIETY has a definite procedure for the selection and election of its officers. Certainly, I am not in a position to question the wisdom of the nominating committee nor that of the membership as a whole in nominating and electing your president for the coming year. With the wholehearted support given by your retiring president, officers and membership, and knowing there can be no doubt as to its continuance, I can only say that deeply appreciating the honor conferred, I shall, to the best of my ability, endeavor to measure up to the high standards of the work of this Society, and continue in the path so successfully pursued by my predecessors. Without your active help success is impossible. Relying upon your continued assistance, I hope that I may be instrumental in promoting the best interests of the Society.

About nineteen years ago, due to the foresight and untiring efforts of the founders, the AMERICAN WELDING SOCIETY began its labors in a field then uncharted and unexplored.

There has been continuous and healthy growth. This is particularly evidenced by the rather minor effect which the late depression had. Since 1933 there has been a continuous and accelerated increase.

* Delivered at Business Session, A. W. S., Atlantic City.

While it is realized that we are dealing with a new process, and working in the twentieth century, the comparison of membership and growth with the first score of years of the four founder societies indicates that we have had a growth at least equal to them, considering members and associate members alone. If all classes of members are considered then our Society has indeed had a marvellous development. While it may be said that the society's activities are specialized, it should be remembered that welding is of interest to all users of metals.

The time since nomination has been largely spent in sitting with your board of directors and executive committee. The object has been to formulate a policy for the Society. This will be presented to you through your board of directors with the sincere hope that the AMERICAN WELDING SOCIETY will continue to progress in the future as it has in the past under the able leadership of my predecessors.

In general, may I suggest that membership solicitation be largely confined to engineers, executives, supervisors, instructors and selected welding operators who are interested in the science and art of welding from the engineering, design and managerial phases.

Discussions among members of the Society in the last year have led to the impression that the character of our society is a matter of deep interest. The general conception is that a technical society is composed of individuals who act as such.

A trade association is composed of company representatives, and the opinions of these representatives reflect the ideas of their parent organizations. Another distinction between the two may be drawn in the nature of control. In the technical society each member has a vote, and the user element does and should predominate. The reverse is quite *properly* true in the trade association. In drawing these distinctions there is no inherent conflict of ideas. Welding is a horizontal industry, involving several processes interesting to all users of metals. Quite properly there should be trade associations to commercially advance the various materials, processes and equipment. This may be termed publicity, sales promotion, advertising, salesmanship or what you will. Such associations definitely need a central *technical* Society, separate and independent, which will, in a technical way, lay down, after thorough study of all available data and as a result of research—codes—specifications—rules of recommended procedure and practice. The two types of Society not only can but should live side by side in harmony with each other, and complement each other's activities. The AMERICAN WELDING SOCIETY is and will continue to be of vast help to the welding industry, both manufacturers and users. This Society, it is hoped, will continue and progress as a technical Society.

In conclusion, Sir Francis Bacon observes:

"I possessed a passion for research—a power of suspending judgment with patience—of meditating with pleasure—of dissenting with caution—of correcting false impressions with readiness—and of arranging my thoughts with scrupulous pains. I had no hankering after novelty and no blind admiration for antiquity. Imposture in every shape I uterly detested. For all these reasons I considered that my nature has as it were a kind of kinship and connection with truth."

This is a worthy philosophy for the AMERICAN WELDING SOCIETY.

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## Our Senior Vice-President

### COLONEL GLENN F. JENKS

Born at Deansboro, N. Y., June 13, 1880. Graduate of Hamilton College (Clinton, N. Y.) B.S. 1901, M.S. 1904. Graduate of Army War College (1924) and of Harvard Business School (M. B. A. 1930). Entered the Army as a 2nd Lieutenant, Artillery Corps, 1901, and detailed in the Ordnance Department, 1903. During the World War served as Colonel, National Army, at Headquarters A. E. F., and at Headquarters Service of Supplies A. E. F. in charge of technical work in heavy artillery in the Office of the Chief Ordnance Officer, and for two months prior to the Armistice as Chief Ordnance Inspector of Artillery at Headquarters First Army. Was decorated by the French Government as Officer of the Legion of Honor and was awarded the Distinguished Service Medal by the American Government.

Since the war served in the Office of the Chief of Ordnance in charge of engineering and production of artillery material, and later in the 8th Corps Area as Chief Ordnance Officer. Was at Watertown Arsenal as Director of Research for two years and then in command from 1932 until 1937, when assigned as Chief of the Technical Staff in the Office of the Chief of Ordnance, U. S. Army. Promoted to the grade of Colonel, Ordnance Department, November 1, 1933.

Member of the A. W. S., A. S. M. E., A. I. M. E., A. S. M., A. S. T. M. and S. A. E. Member of the Engineering Foundation Welding Research Committee and Chairman of the Industrial Research Division of that Committee.

Col. G. F. Jenks—Senior Vice-President American Welding Society

## Samuel Wylie Miller Memorial Medal

The Samuel Wylie Miller Medal, an annual award of the AMERICAN WELDING SOCIETY presented for meritorious contributions to the science and art of welding, has been awarded to H. Sidney Smith. It was established in 1927 by the late Samuel Wylie Miller, himself an outstanding figure in the development of welding since its inception. For a great many years, and until the time of Mr. S. W. Miller's death, Mr. Smith and Mr. Miller —whose memory is commemorated by the Miller Medal—were closely associated in their technical, business and engineering society activities. Each of these men contributed greatly to the efforts of the other and their complementary thinking on many subjects resulted in real progress for the oxyacetylene industry. It is therefore appropriate to a special degree that the Committee has seen fit to award this medal to Mr. Smith.

H. Sidney Smith

Well known in the acetylene industry both in America and abroad, H. Sidney Smith has served as president of both the British Acetylene Association and the International Acetylene Association and has been directly responsible for many important developments in acetylene utilization.

Born in Newark, England, and educated as an electrical engineer at the Nottingham University, after leaving college he worked with the firm of Messrs. Robey & Company and then for a time with the Brush Electrical Engineering Company, Ltd. In 1896 he joined the Acetylene Illuminating Company, Ltd., who were experimenting with the manufacture of calcium carbide at Leeds Forge. He assisted in the preliminary experiments there and in conjunction with Mr. S. G. Worth (the founder of the British Acetylene Association) turned out the first calcium carbide made in Great Britain on a commercial scale. This work was done at the Falls of Foyers—Portland.

In 1901 Mr. Smith began experimenting with the use of dissolved acetylene and also with oxyacetylene welding. The use of

Chairman Adams Presents the Medal

dissolved acetylene was sanctioned by the British Home Office largely as a result of these experiments. General Manager of the Acetylene Illuminating Company and also of the British Autogenous Welding Company, Ltd., and in 1910 he was elected President of the British Acetylene Association.

In 1911 he came to America and joined The Prest-O-Lite Company, Inc., at Indianapolis, becoming Works Manager in charge of all gas plants and in 1918 became Consulting Engineer for Union Carbide Company.

In his long and active career with Union Carbide Company and its associated companies, he has made many important contributions to the oxyacetylene industry, and has been the author of innumerable technical articles on the uses of oxygen, acetylene, calcium carbide and oxyacetylene apparatus. One of the first instruction manuals in oxyacetylene welding and cutting was written by Mr. Smith and he has been active in the technical training of many men who are now taking leading parts in the engineering aspects of the industry.

His significant contributions to the subject of industrial safety and fire prevention are many, especially in matters involving the transportation and use of industrial gases and the use of the oxyacetylene process. He has worked actively with insurance and regulatory bodies in developing and applying rules and procedures to improve the safety standards of the industry. Mr. Smith's work has contributed vastly to the acceptance of the oxyacetylene and the compressed gas industries as being among the best regulated of American industries from the standpoints of safety and accident prevention.

Elected President of the International Acetylene Association in 1920 and President of the Compressed Gas Manufacturers Association in 1928, Mr. Smith also has been for many years a director and a member of the Executive Committee of the AMERICAN WELDING SOCIETY. He is also a member of the American Society of Mechanical Engineers, the American Society for Testing Materials, the National Fire Protection Association, The National Safety Council, The American Society of Safety Engineers, and a number of engineering groups. In practically all of these associations Mr. Smith has served in important executive capacities.

One of Mr. Smith's outstanding qualities has always been his ability and his willingness to pass along to younger men in the industry the ideas and lessons he has learned through his long association with the technical aspects of the business. The value of the service that Mr. Smith has rendered and is rendering to the industry in this regard can never be properly appraised.

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## Address by Edward G. Budd, President Edward G. Budd Mfg. Co., Philadelphia, Before Opening Session, AMERICAN WELDING SOCIETY Hotel Traymore, Atlantic City, Monday, October 18, 1937

This is an honor for me. If you had wanted a pep talk you would have selected one of those in active welding work, and yet I fear I cannot say much, unless as a boost to your own plans. To me Gee was always a better word than Whoa. If I talk history I would just prove to you that I am passe.

We used the first oxyacetylene apparatus used in the United States. Bournaville, imported from France. We made our own oxygen and acetylene. My staff did the first spot welding on a commercial scale. Thompson apparatus, and later

E. G. Budd

with the active assistance of Morris Lachman, a very able man, whom I have always held in high regard as a person.

The staff of younger men who have carried on this class of work in our factory have kept in advance of the art. In the manufacture of car seat pedestals we applied electric butt welding to irregular shapes as early as 1904. This was then a step toward flash welding of automobile parts, and welding two long sheets into a

wide sheet, which met the automobile demand for wide sheets before the steel mills were equipped to make such sheets at economical prices. Then at last, the shot weld which is applicable to certain high alloy steel, which we wished to introduce into the structural field.

This is all old information, and does not concern the present problems, except so far as a review may give inspiration to the present situation. You talented and educated welders will soon be arguing your various views, and I am sure the friction of wits here will advance the art.

In the few minutes I am here, I want to say something of the civic or spiritual side of our adventure. There is much of disparagment nowadays of the endeavors of us workers. Thoughtless and inexperienced people hold the center of the stage and make unfavorable comparisons between us and the artisans who worked hundreds and thousands of years ago. They call us money-minded doers of shoddy work. We know this is not true, but we are very busy with the work of our brains and hands, and seldom listen to the talk. The Greek statue cannot be surpassed by us, and that contribution we bow before, but God made the subject they have depicted, and our rendering tribute to their work is a sign of our trained perceptions. The Greek philosophers we look to as we look to other of God's prophets, and we have no power but to use the good things they left to us. Generation builds on generation. The lines and colors of their architecture help the modern architect to give grace to forty-story buildings.

Coming closer to our own part of the world's work, we survey the work of the great furniture builders of the seventeenth and eighteenth centuries. Their lines are correct. Little can be done to improve them, but we can copy their designs so that people of small means can have the culture which comes from the daily use of correct styles. If we cannot improve design we can improve the workmanship. We have better joints more neatly made, and more securely put together. We have better veneers and inlays, and put them on more securely. We build up our sections so that they are less likely to split or warp. There are few firms in America who will fit doors and drawers so that they are smoother to operate than on any of the old furniture. It is in the consideration of these joints and framing that we approach our own art. Metal brought its problems. The use of tenon, mortice, wood screw, and peg or trenail, which were developed to suit wood construction over the ages past—all this found no application with metal. Screws and rivets at first; then came our welding arts; all the work of our own generation and of you men here. The problem was first solved with mild steels, and recently the development of various alloy steels has necessitated a study and discovery which has in intricacy and value been as proud an accomplishment as the original spot welding development.

Here agam is where integrity was called for. Joints made of wood, the best of them, were weak, and varied greatly one from another, with the various qualities of wood used, the accuracy of fabrication, the quality of glue, and the skill of its application. The rivet used in the metal work gave better security at joints. The spot weld was better still, but control of current and of its application was at first irregular. In our automobile business, when we needed three welds for a stress, we put in five for safety. Then came the marvelous alloy steels. In our own shop we planned to use 18-8 for airplane work. The uncertainties of welding which were excusable in automobile work, were not excusable in airplane nor in railroad work. Hence came the shot weld. I am proud, and disposed to be boastful of our own people who are associated with your work, but it is pleasant to think of their work as keeping pace with the high sense of honor which prevails among the artisans of the world. This struggle for integrity is called to mind to refute the defeatist talk with which we are assailed.

The ironmaster gives us irons which are marvelous and beautiful in structure and properties. Crystal upon crystal bound together and held apart as are the stars. These are seasoned or tempered by additions of proper condiments to give strength or hardness, or ductility, all qualities accurately predetermined in the bath and between the rolls.

Then it becomes our responsibility to so attach one of these pieces of metal to the other, as to maintain the quality in the whole structure which exists in the single piece. One piece is cemented to the other by melting a minute particle between them. The heating is done by an exact amount of electricity, metered with infinite accuracy. Honesty, intelligence, and integrity, with great personal skill, give results which outdo the works of our fathers. We do not attempt shoddy economy by clipping the amperes or volts, but one hundred per cent is metered out. We do not advise sparing our engineering foresight, but in our structures amply provide for the shock and blow of future contingencies. In the successive steps in our operations, e ach workman gives freely of his talent, and does not limit his hours of labor or like lame men ask Government to help him over his difficulties.

In the midst of social and governmental discussions, you men and your staffs, with all the great body of working citizens give assurance of eventual, wise decision and sound government with a cultivated and inspired citizenship.

## New Fire Prevention Booklet

A new booklet "Preventing Welding and Cutting Fires," just published, should be useful to all those interested in welding or cutting operations.

The booklet is an important part of the nation-wide program to promote safe practices among the users of industrial equipment. It includes safe and sure rules to follow for preventing the possibility of welding or cutting fires, as well as other pertinent information.

Copies of this useful booklet may be obtained free upon request from The Linde Air Products Company, New York.

## "The Characteristics of a Modern Arc Welder"

Entitled, "The Characteristics of a Modern Arc Welder," this new folder is an interestingly written technical description of how modern welder design meets all the requirements of present-day welding operations. Giving volt-ampere curve analysis for general welding, heavy welding and light-gage welding, it goes into single-current control, self-excitation and other pertinent points in the design and construction of Welding Generators.

Written by Frank J. Hirner of the welder division of Harnischfeger Corporation of Milwaukee, it helps clear up many points that were heretofore not thoroughly understood. Copies may be had by writing the Harnischfeger Corporation, 4400 W. National Avenue, Milwaukee, Wisconsin.

## Cable from Jennings

Members of the AMERICAN WELDING SOCIETY attending the Annual Dinner in Atlantic City were very much pleased to receive a Cable from Mrs. Charles H. Jennings of the Westinghouse Electric & Mfg. Co., who is visiting England for several months in connection with some consulting work. Mr. Jennings' Cable read "Best Wishes for a Successful Convention."

## New Technical Bulletin

Arcos Corporation has issued a new technical bulletin entitled "The Arc Welding of Stainless Steel Industrial Equipment." This bulletin includes information of value to welding engineers, designers, operators and metallurgists on the problems encountered in the arc welding fabrication of the straight chromium and the chromium-nickel alloys. Under their own headings it covers the 2% and 4–6% chromium as well as the 16% and 18% straight chromium alloys. The austenitic series covered includes the 18/8, 25/12, 25/20 and higher chrome-nickel alloys. There is an article covering welding technique which is of particular interest to the operator. It also contains an article on the testing of stainless steel welds for corrosion.

## Iron and Steel Engineer's Convention

Among the papers presented at the Iron and Steel Engineers' Convention at the Stevens Hotel, Chicago, the week of September 26th, were the following papers on welding:

"Alternating Current Arc Welding Advance," by C. J. Holslag, Electric Arc Cutting & Welding Co.

"Welding Economics and Application," by E. W. P. Smith, Consulting Engineer, The Lincoln Electric Co.

"The Development and Application of Covered Electrode Arc Welding," by A. M. Candy, Consulting Engineer, Hollup Corporation.

## Steel Houses

*White Sulphur Springs, W. Va., Oct. 27th.*—Long-range economy is the outstanding advantage of steel housing, F. T. Llewellyn, research engineer of the United States Steel Corporation told the annual convention of the American Institute of Steel Construction here this afternoon. Mr. Llewellyn's paper was the main topic of a special round-table meeting planned for house builders. This type of house surpasses protection against termites and added safety against fire, two advantages of steel housing generally regarded by the public as most outstanding, he said.

"The first cost of steel housing is nearly always more than for other methods now in use," Mr. Llewellyn explained, "but this factor promises to be more than offset in after years because the non-shrinkability of steel gives a more efficient structure which requires lower maintenance costs.

"Of paramount importance in considering the use of any material for framing is the question of possible changes in dimension during the life of a residence," he added.

"Any perceptible shrinkage of the framing material is attended by such evils as cracking of tile and plaster, the misfit of doors and windows, and the opening of joints in the walls, resulting in the infiltration of air and moisture which run up heating costs."

"The use of adequate steel framing will either avoid or greatly reduce all of those troubles and will give positive assurance of stability and low maintenance cost throughout the life of the structure," Mr. Llewellyn predicted.

More than 1400 homes using steel as a major building material have been built in the United States, Mr. Llewellyn estimated. Some 3000 others have used steel to lesser degree.

With the small steel house requiring five tons of steel, our annual demand of 300,000 homes in the country makes a potential market of 1,500,000 tons of steel every year.

Steel construction would eliminate 70 per cent of residential fires which start below the first floor and 15 per cent more which start on the roof, but this is not an outstanding advantage because residential fires are rare and insurance rates already quite reasonable, it was pointed out.

In his paper, "Light-Gage Flat-Rolled Steel in Housing," Mr. Llewellyn emphasized the structural rather than the architectural features of houses. He cited as affecting the utilization of steel housing the tendency toward no basements; an increase in flat roofs with portions used for living purposes; more glass in walls; disposition of windows near corners; and the increasing demand for standardized, mechanical units such as fabricated kitchens and bathroom equipment.

Part of Mr. Llewellyn's paper was devoted to taking the "bunk" out of steel housing and dispelling any belief that it will be an immediate panacea for all of our residential ills. Strength of steel as demonstrated in buildings and bridges along with unwarranted publicity given to model steel houses built in the past has helped to create in the minds of the public the false impression that the all-steel home was just around the corner within the reach of everybody's pocketbook.

As his contribution to this saner viewpoint, Mr. Llewellyn spent many months in collecting data on the characteristics of seventeen types of steel houses. For the first time on record, he gathered these together in a paper accompanied by comprehensive descriptions and detailed dimensional drawings.

According to Mr. Llewellyn, steel is seeking its own level of usage in housing.

# SECTION ACTIVITIES

### BIRMINGHAM

At a meeting held on September 15th at the Tutwiler Hotel the following were elected as Officers of the Birmingham Section.

Chairman—E. E. Michaels, Chicago Bridge & Iron Co., P. O. Box 277.

Vice-Chairman—J. T. MacKenzie, American Cast Iron Pipe Co., Birmingham.

Secretary-Treas.—J. E. Durstine, Lincoln Elec. Co., 505 No. 22nd St.

Executive Committee—2 year term:

| | |
|---|---|
| R. E. Jones | W. P. Roberts |
| R. H. Ledbetter | A. J. Beldon |
| J. W. Adams | J. P. Flood |

1 year term:

| | |
|---|---|
| E. J. Johnson | J. B. Thompson |
| W. P. Rierson | I. T. Lindsey |
| F. E. McAtee | R. D. Keller |

### BOSTON

The first regular meeting for this season is scheduled for Friday evening, October 29th at the West Lynn Works of the General Electric Company.

Dr. C. G. Suits, General Electric Company, Schenectady, New York, will be the first speaker on the program and has chosen for his subject—"Properties of an Arc," and will use high-speed motion pictures to illustrate his talk.

The second speaker will be Mr. E. D. Debes, Bethlehem Shipbuilding Corp., Quincy, Mass., a member of the Boston Section, who will discuss an important subject—"The Selection and Qualification of the Men Who Weld."

Other dates for meetings of the Boston Section this season are as follows:

Friday—November 19, 1937
Monday—December 27, 1937
Friday—January 21, 1938
Friday—February 25
Friday—March 25
Friday—April 22

Interesting programs are being arranged for these meetings and will be announced soon.

The Boston Section is represented by two of its members on the Program for the Annual Meeting at Atlantic City, October 18th to 22nd. At the Technical Session on Industrial Research on Monday afternoon, W. L. Warner, of the Watertown Arsenal, and Vice-Chairman of the Boston Section, will talk on "Weldability of Low-Alloy Steels."

At the Technical Session on Fundamental Research in Welding scheduled for Tuesday afternoon, Mr. H. R. Bullock of the Mass. Inst. of Technology, and Chairman of the Meeting and Papers Committee of the Boston Section will present "High-Speed Motion Pictures of Flame Cutting."

P. J. Horgan, Chairman of the Boston Section, is to attend the Annual Meeting at Atlantic City, to represent this Section.

### CHICAGO

A meeting of the Program Committee was held on October 4th. It was decided due to the annual convention in Atlantic City that there should be no local meeting in October.

The time of the monthly meetings was decided upon as the third Friday of the month up to and including the May meeting, which will be the last of the season. For location of meetings it was decided for the present to continue at the Skytop Roof located on the top floor of the Medical and Dental Arts Building, 185 N. Wabash Avenue (Corner of Lake St.). An effort is to be made to appeal to a greater number to come for dinner preceding the meeting.

An invitation has been received by the Chicago Section inviting them to meet jointly in January on the third Friday with the Western Society of Engineers. The invitation has been accepted.

It was decided to offer three free dinners at each meeting as door prizes. Only those returning reservation cards are eligible for the prize.

The following is the tentative program for the coming season:

November 19th—A. E. Gibson.

December 17th—Subject "High Pressure—High Temperature Piping."

Jan. 21, 1938—Joint meeting with Western Society of Engineers.

February 18th—Paper by C. H. Jennings, Westinghouse E. & M. Co.

March 18th—Heat Effect in Welding—Dr. W. G. Theisinger, Lukens Steel.

April 15th—Hard Facing in Industry, by E. Smith, Haynes-Stellite.

May 20th—Codes and Education in Welding.

### DETROIT

The opening meeting of the Detroit Section of the 1937–38 Season was held on Wednesday, October 6th at The Detroit Edison Company Auditorium. Mr. John D. Gordon, General Manager, Fabricating Div., Taylor-Winfield Corp., spoke on "Rolled Steel Construction in Machine Design," which was illustrated with moving pictures showing the fabrication of steel from the Engineering Department through the Fabricating Plant and the

Machine Shop, with a running description of the operations. Attendance at this meeting broke all former records.

### KANSAS CITY

The October meeting of this Section was held on the 25th at the Kansas City Power and Light Co. Building. An address on "Comparison of Electric Welding and Brazing High Carbon Wire for Wire Rope," was presented by Mr. Walter Voigtlander, Chief Engineer, Union Wire Rope Co. Mr. Voigtlander's talk was illustrated with slides. An informal discussion followed.

### MARYLAND

The following is the program for the Maryland Section from October 1937 to April 1938, inclusive.

October 30, 1937—Second Annual Oyster Roast (Get-together meeting).

November 19, 1937—Harry W. Pierce, New York Shipbuilding Corp. on "Welding in Shipbuilding."

January 21, 1938—Arthur N. Kugler, Air Reduction Sales Co., on "Multiple Pass Gas Welding."

February 18, 1938—T. W. Greene, The Linde Air Products Co., on "Testing Welds."

March 18, 1938—Joint Meeting with A.S.M.E.—C. H. Jennings, Westinghouse E. & M. Co., on "Welding Design."

April 8, 1938—A. F. Davis, The Lincoln Electric Co., on the "Human Side of Welding."

### MILWAUKEE

The opening meeting of the 1938 season was held on Friday, October 15th at the City Club of Milwaukee. Dinner preceded the Technical Meeting. Mr. W. V. Emery, Chief Welding Inspector of the Harnischfeger Corp., presented a talk on "Shop Organization and Practical Problems in Welding." Following the talk, several well known shop executives gave their views on the subject.

### NORTHWEST

The Northwest Section, which was organized only last July, is now fully under way and the officers and executive committee are looking forward to a very successful season. It is felt that the Section will be a decided asset in the industrial life of our territory, and that it will be of distinct value to those in the welding field.

At the meeting of the Section held September 27th at the Minnesota Union, University of Minnesota, H. C. Boardman, Research Engineer of the Chicago Bridge & Iron Company, Chicago, gave an intensely interesting and vivid description of some of the important phases of welding, his subject being "Fabrication of Tanks in the Shop and in the Field." His talk was illustrated by lantern slides, which were a revelation to many of our members because of the magnitude of the installations and the complex problems that were involved.

The Section now has some fifty-four members and new ones are joining frequently. It is planned to conduct a quiet but persistent membership drive in the near future, which will undoubtedly add a number of new members to the Society.

The Section has had the misfortune to lose its very able and efficient chairman, H. J. Kicherer, who has left St. Paul to accept a position with greater responsibility in Chicago. Mr. Kicherer has always been keenly interested in the art and science of welding, and was the principal force that promoted the Northwest Section. Our members wish him every success in his new connection.

### OKLAHOMA CITY

The organization meeting of the Oklahoma City Section was held Monday evening, September 27th in the Biltmore Hotel, with an attendance of 31, mostly members. The following officers were elected:

Chairman—O. T. Barnett, Black, Sivalls & Bryson, Box 1377, Oklahoma City.

Vice-Chairman—M.G.Mossholder,Okla. City Machine Works.

Treasurer—Otto Hart, Hart Welding Supply, 409 W. California.

Secretary—K. B. Banks, P. O. Box 1377, Oklahoma City, Okla.

Representative on the Natl. Board of Directors—G. Raymond, 3110 N. W. 20th St.

Member of the Natl. Membership Committee—O. B. Fulton, Hart Welding Supply, 409 W. California.

The meeting opened with Temporary Chairman O. T. Barnett presiding and his opening remarks were followed by a brief history of the organization Section given by the Temporary Secretary K. B. Banks.

G. Raymond gave a few remarks on the outlook and possibility of welding.

M. G. Mossholder gave a brief talk on the welding of cast iron.

The first regular meeting of the Oklahoma City will be held on November 2nd. Subsequent meetings will be held the first Tuesday of each month.

### PHILADELPHIA

The 1937–38 Program of the Philadelphia Section is as follows:

October 19, 1937—Philadelphia Day at the Atlantic City Convention of the AMERICAN WELDING SOCIETY at Hotel Traymore.

November 15, 1937—8:00 P.M., Engineers' Club, Philadelphia. New Developments in Welding—Flame Hardening—Multi-Pass Welding, by Dr. G. V. Slottman, Air Reduction Sales Co.

January 17, 1938—8:00 P.M., Engineers' Club, Philadelphia. Electric Welding Progress, by J. F. Lincoln, The Lincoln Electric Company.

February 21, 1938—8:00 P.M., Engineers' Club, Philadelphia. Fabrication and Uses of High Yield Strength Alloys—U. S. Steel Corporation.

March 21, 1938—8:00 P.M., Engineers' Club, Philadelphia. The Uses of Castings in Heavy Welding Assemblies—Mr. Jessup, S. Morgan Smith Company.

April 18, 1938—8:00 P.M., Engineers' Club Philadelphia, Welding in Modern Building Construction—E. L. Durkee, Bethlehem Steel Corp.

May 1938—Inspection trip.

### PITTSBURGH

The opening meeting of the 1937–38 Season was held on Wednesday night, October 13th, in the Blue Room, Roosevelt Hotel. Retiring Chairman, E. J. W. Egger, presided and introduced the newly elected officers, Chairman Leon C. Bibber and Vice-Chairman J. O. Rinek. Over seventy-five members and guests were present and heard a most interesting and enlightening talk by Mr. A. E. Gibson, retiring President of the AMERICAN WELDING SOCIETY and President of The Wellman Engineering Co., on what the AMERICAN WELDING SOCIETY has done this past year. Following this talk on the Society, Mr. Gibson presented a most interesting talk on the "Use of Rolled Steel in Welded Construction" showing slides of many examples of welded machinery to illustrate his talk.

Mr. Warner S. Hays, Managing Director of the A.W.S., was also present and gave a very clear account of the activities of the AMERICAN WELDING SOCIETY, including the establishment of new Sections, the drive for members and the prospects for the unlimited growth of the Society in the years to come.

Preceding the regular meeting a dinner, open to members and guests, was held in the Coffee Shop and was well attended. This will be a regular feature for all future meetings.

### SAN FRANCISCO

The October meeting of the San Francisco Section was held on the 22nd at the South San Francisco Plant of the Western Pipe & Steel Co. The meeting was preceded by a dinner at the Olivers Restaurant. The practical side of the Shop Fabrication of A. P. I.-A. S. M. E. Pressure Vessels for Oil Refineries and Chemical Industries was discussed by Mr. H. S. Brink, Boiler Shop Foremen of the South San Francisco Plant of the Western Pipe & Steel Co.

As usual, interesting reviews of the more important articles in THE WELDING JOURNAL were given.

### WASHINGTON

The following officers have been elected by the newly formed Washington Section.

Chairman—A. G. Bissell, Bureau of Construction and Repair, Navy Department, Washington, D. C.

Vice-Chairman—R. B. Swope, Southern Oxygen Co., Arlington, Va.

Secretary—C. A. Loomis, Bureau of Construction & Repair, Navy Dept., Washington, D. C.

Treasurer—R. F. Wood, Wm. M. Corse Chem. & Met. Engr., 810 18th St., N.W., Washington, D. C.

Executive Committee—For 2 years:

| | |
|---|---|
| W. F. Dietz | G. F. Jenks |
| W. S. Farr | C. M. Underwood |
| R. P. McMillan | R. K. Wells |

For 1 year:

| | |
|---|---|
| (To be elected after affiliation with Section) | H. W. Hiemke |
| | G. E. Knox |
| | H. L. Whittemore (member) |

Representative on National Board of Directors—A. G. Bissell.

### SOUTH TEXAS

The South Texas Section held their organization meeting Thursday evening, October 7th at the Ben Milam Hotel, Houston. The meeting was opened by temporary chairman, Mr. Walter B. Van Wart, who gave a brief introduction outlining the activities of the temporary membership committee appointed at the recent meeting. Regional Vice-President Edward E. Dillman, briefly outlined the aims and benefits of the Society.

A short moving picture was shown by a visitor, Mr. Charles E. Van Wart. This picture showed the complete construction of an all-welded steel storage tank by the Wyatt Metal & Boiler Works, and also showed the fabrication and construction of welded line pipe in the Wyatt Metal & Boiler Works Shop, together with the installation in the field.

The following officers were elected:

Chairman—Marvin Cook, Humble Oil & Refining Co., Houston.

Secretary-Treas.—Malcolm V. Reed, Wyatt Metal & Boiler Works, Houston.

Executive Committee—2 year term:

| | |
|---|---|
| B. W. Farquhar | G. Steffen |
| Joe Kane | W. S. Winn |
| H. M. Stewart | P. J. Kegg |

1 year term:

| | |
|---|---|
| J. J. Netherwood | J. F. Pryor |
| Frank Fowzer | B. K. Smith |
| D. R. Pflug | W. G. Baker |

### YOUNGSTOWN

The Youngstown Section held a meeting on Monday, October 11th at the Ohio Hotel and a very interesting talk was given by Mr. Verg Whitmer, a metallurgist for the Republic Steel Corporation, on Welding Alloy Steels.

At present the Section plans to meet the second Monday of each month and until further notice, meetings will be held in the Ohio Hotel, Youngstown, Ohio.

## Sections Under Development

### COLUMBUS, OHIO

A preliminary conference of some sixteen representatives of the Engineers' Club, Ohio State University, users of welding and representatives of manufacturers and distributors of welding accessories, equipment and supplies in Columbus, was held on Oct. 1st and plans laid for a preliminary joint meeting on Welding with the Columbus Engineers' Club. Prof. O. D. Rickley of Ohio State is Chairman of the Committee having meeting underway, assisted by F. S. Caldwell, Jeffrey Co., and D. E. Van Ness, International Stacey Co. and others. The plan is to hold the meeting sometime in January and conclude formation of Columbus Section at that time.

### MIAMI VALLEY

The important section of welding centers like Dayton, Piqua, Springfield and Troy, on Oct. 1st held their first preliminary meeting to form a Section of the A.W.S. at the Engineers' Club, Dayton.

F. L. Meachram, Frigidaire Div., General Motors Corp, Chairman of the Program Committee of the Club, presided. Over 100 attended. Dr. J. C. Hodge of Babcock and Wilcox Co., gave an interesting presentation, with slides, of "The Fundamentals of Welding," in his inimitable manner.

After his talk the benefits of a Section of the A.W.S. were stressed by members of the Society and E. Stensel was elected Temporary Chairman to name a Committee to proceed to organize the Miami Valley Section.

### ST. LOUIS

Using return cards and keeping check on results the Committee was able to handle the extraordinary attendance at the Oct. 12th meeting. There were 1355 present at the meeting which was held at the German House with two other halls being used for refreshments after the meeting. Over 265 firms were represented which showed that the committee had done a fine promotional job. From 8:15 to 8:30 a reel of movies on Spot Welding was shown. Then the speaker of the evening, Mr. J. D. Gordon of the Taylor-Winfield Corp., Detroit, gave his talk on "Re-Design of Simple and Complicated Parts to Fabricated Steel." They broke all former records for their annual educational meeting.

While East at the A.W.S. Convention, Chairman Harris reported that on Nov. 4th the Engineers' Club of St. Louis holds its joint meeting with the Section. F. C. Fantz, Midwest Piping and Supply Co., will speak on "Progress of Welding in Industry." The Section has also been asked to name an Advisory Committee for the Hadley Vocational School to assist in making layout of welding equipment necessary to equip and the selection of Instructors and to guide the course. The Section has worked diligently for months to bring this about and to make use of Smith Hughes Federal funds for this vocational training on welding.

### INDIANAPOLIS

The Indianapolis Chapter of the American Society for Metals held a joint meeting with the AMERICAN WELDING SOCIETY on September 27th at the Hoosier Athletic Club. Mr. A. E. Gibson, President, The Wellman Engineering Company addressed the meeting on "The Welding of Low-Alloy Steels."

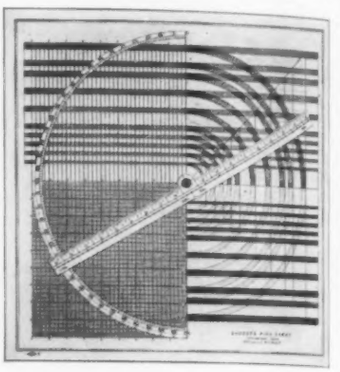
Plans are proceeding to complete the Central Indiana A. W. S. Section at the time of the Purdue Welding Conference Dec. 9th and 10th.

### FORT WAYNE, INDIANA

The Engineers' and Foremen's Clubs of this City held a joint dinner meeting with AMERICAN WELDING SOCIETY on September 23rd. Over 250 were present. Divisional Vice-President H. C. Boardman addressed the meeting on "Tank Welding in the Field." During the discussion an invitation by members of the Society was extended to all to join the A.W.S. and benefits of membership were stressed. James McClure of the Wayne Welding Supply Co., Inc. is Chairman of the Committee arranging the meeting and developing a Section of the A.W.S. in Northeastern Indiana.

## Rhoades Pipe Layout

The Society has received a very interesting manual and miniature chart from the Victor Equipment Company, San Francisco, showing how with the use of this chart the pipe welder can obtain easy effective layout results in the shortest way.



All the "cut-back" measurements of miters for making angles which total a possible 1000 may be read as quickly as the revolving arm can be turned.

By simply turning the arm to the specifications a possible 25,000 triangles and offsets are solved completely.

All the measurements for simple saddles which total 600 and upward may be obtained with the use of a pocket rule or dividers as quickly as the previously mentioned operations.

## Machining Aluminum

An attractive revised edition of the booklet, entitled "Machining Aluminum" containing detail data on the machining of aluminum and its alloys has been prepared by the Aluminum Company of America, Pittsburgh. Copies may be obtained on request.

# EMPLOYMENT SERVICE BULLETIN

### SERVICES AVAILABLE

A-242. Young Engineer would like sales or engineering design work. Am 26 years. Single. Am Junior Member, A.S.M.E., Associate Member, A.W.S. Have worked for the R. Hoe and Company as draftsman and am at present employed with a machinery company as Machine Designer. Have several years practical experience in welding, both gas and arc, and machine shop work.

A-243. Arc and gas welder desires position. Have had a thorough training course in welding and one year's experience.

### POSITION VACANT

V-83. Job for a man with technical education, experienced in welding, who can talk welding. It is not for selling. Salary would be $300 to $400 a month to start.

# Report of President A. E. Gibson

Gentlemen of the
AMERICAN WELDING SOCIETY:

One year ago, at our Annual Meeting, the Society embarked upon a new course through which certain objectives, highly desirable from the standpoint of technical advancement and prestige in scientific and industrial circles, were undertaken.

The progress made this year is known to most of you. Later on this progress will be briefly outlined by the gentlemen who as chairmen contributed so much to our year's progress.

It was most fortunate that this past year was a period of industrial prosperity. This has reflected itself not only in a phenominal growth in membership, but in financial support from industry, which permitted activities on a scale previously impossible.

While the AMERICAN WELDING SOCIETY is a technical society concerned with the development of the art and science of welding, there is no reason why these objectives should not also prove to be an aid to the industrial use of welding.

I am particularly pleased with the increase in our local sections. Every thriving center of welding, with sufficient diversification, should support a chapter of the AMERICAN WELDING SOCIETY. Through these sections is brought to our members the latest developments of the art and the practical application of them to industrial problems by men who speak with authority. In the final analysis, the practical use of science should be our main objective.

*Report on Society Committee Activities.*—As complete report of the various committees is available in the Society files, it is believed desirable in this report to touch only on the principal events or accomplishments of the administration.

*Welding Symbols.*—Your Committee on Nomenclature, Definitions and Symbols has prepared and offered for adoption revised welding symbols and instructions for their use. After approval by your Board of Directors, these symbols were published in the June 1937 issue of the Society Journal and reprinted in bulletin form. Many copies have already been sold of this new standard.

These revised symbols have been adopted by the various technical bureaus of the United States Navy, and have been offered to the American Standards Association with recommendation for adoption as an American standard. A chart of the major welding processes is practically complete and will be offered shortly for approval and publication.

Work on definitions is being delayed awaiting the chart's approval, as many definitions hinge on the relationship of the various processes to each other.

*Filler Metal.*—After seven years of arduous labor, your Committee has brought about the issuance of a specification for Iron and Steel Filler Metal that has been adopted and published jointly by the A.S.T.M. and your Society. This result should be gratifying to the entire welding fraternity.

The Committee will be called upon to consider revisions of the specification developing from time to time. It will also give consideration to the preparation of a specification for alloy steel filler metal, and to the standardization for coloring ends of various grades of electrodes.

*Building Code.*—Your Committee continued to cooperate with the Special Committee concerned with the progress of the new Building Code proposed for New York City. The recent enactment of the Building Code by the City, with recognition of structural fusion welding and of resistance welding for bar joists and similar products has removed the need for further efforts to obtain recognition in that quarter, but there may be need for other work in advising building officials on administration of the welding processes.

Your Committee has answered inquiries from individuals and organizations, including building officials and committees of other societies regarding the A. W. S. Code No. 1 and related matters. The Committee has collected information about the status of welding in building codes of various cities and towns. The Committee after this noon meeting will offer to the Board of Directors at their meeting tonight proposed revisions of the 1934 edition of Code No 1. These include bringing the various references to other documents and new A. W. S. Codes up to date, and the adoption of a schedule of higher design stresses for welds made with high strength filler metal together with higher test qualifications for operators using such metal.

*Bridge Specifications.*—Since the completion of its work on development of specifications for design, construction, alteration and repair of highway and railway bridges by fusion welding, the Conference Committee on Welding Bridges has devoted its activities to the further development of the subject.

Its efforts to that end may be summarized along the following general lines of procedure:

(1) Clarifying points in the specifications which may be questioned as a result of practical application; and

(2) Securing the adoption of the A. W. S. bridge specification by professional bodies throughout the country.

As a result of work along the latter lines, the American Association of State Highway Officials has agreed to adopt the A. W. S. specification with the exception of unit stresses. It has been placed before the American Railway Engineering Association and the American Institute of Steel Construction. The former Body has given the same serious consideration and definitely recommended the A. W. S. specification for adoption at its Annual Meeting in March 1938.

As a result of concerted efforts on the part of your Committee, the AMERICAN WELDING SOCIETY Bridge Specification is being extensively brought to the attention of the engineering profession throughout the United States. It is being tested in actual practice. The lessons of experience are being carefully analyzed and a systematic effort is being made to bring these specifications through subsequent revision, to a state of perfection.

*Marine Construction.*—Your committee has been devoting its efforts to the preparation of a code for the welding of marine piping and to the amplification of the AMERICAN WELDING SOCIETY Rules for Welding of Hull Construction with a view to incorporating instructions on thermal shrinkage and standard methods of qualifying operators.

A study has been made of thermal shrinkage and stresses, and it is expected that the sub-committee having this matter in hand will report to the main committee during this Annual Convention.

*Oil Storage Tanks.*—Your Committee on Welding of Oil Storage Tanks, after four years of intensive work, completed its report, which was submitted to the Board of Directors at its meeting of September 10, 1937.

Agreement on all details of the report was difficult to obtain. Since the report did not specify any definite amount for the working stresses in the steel plate, merely stating that such stresses should be subject to the dictates of good practice and conform to local statutes, the Board of Directors referred the report back to the Committee with instructions to agree upon a definitely specified working stress.

The Board recommended that a conservative value be adopted for this stress which means that it should be taken at the 18,000 lb. figure rather than the 21,000 lb. amount, which is desired by the petroleum interests. Your committee is now endeavoring to obtain agreement on this point.

*Welding of Gravity Spri[illegible] Tanks.*—Your Committee has been [illegible]gaged in a thorough and complete re[illegible]sion of the Rules for Welding of Gravity Tanks, Tank Risers and Towers. Inasmuch as the fabricators of such tanks have joined in urging that these Rules be compiled into a form as nearly as possible identical with that of the Oil Storage Tank Code, the revision work has been delayed somewhat, but it is now progressing satisfactorily.

*Correlation of Code Requirements for Qualification of Welding Operators.*—Your Committee's activities this year have been confined to interpretation and revision work, the principal revision being that of Paragraph 9 of both Parts I and II in order to incorporate definite wording to show form of limiting test requirements that should be imposed by codes adopting these qualification rules. No actual limiting values were incorporated, however, as this is considered to be the perogative of the code-making body adopting the rules.

An important detail of this revision is the adoption of the "Zones of Defects" method of evaluating porosity and inclusions in weld deposits to replace the much used nick-break test. This form of

test determination has not been fully understood and your committee is arranging a Round Table Discussion on Wednesday afternoon in order to explain and clarify the method. Also other details of the Rules will be there discussed, including a criticism from the U. S. Navy Dept. on the free-bend test specified and another from the Los Angeles Local Section in regard to the bend test requirement in Part II.

Your Committee is pleased to announce that these Qualification Rules have now been adopted by several Codes, including the A. S. M. E. Unfired Pressure Vessel Code, the A. W. S. Bridge Welding Code, the A. W. S. Code for Welding Oil Storage Tanks and the A. W. S. Gravity Tank Code.

*Standard Tests for Welds.*—After a thorough study of the subject, your Committee decided its chief function is to aid in harmonizing the many minor variations now existing between details in the weld testing methods of various codes and specifications—some of a minor nature not greatly affecting results but preventing tests carried out under one specification from being exactly applicable under a second specification;—other variations, notably those in the bend test requirement, are of a more basic character. Your committee has concentrated on producing methods of tests for welds that would help eliminate these variations.

As a result of meetings and exhaustive correspondence, general and with members of the committee, a tentative draft has been prepared and submitted to chairmen of committees sponsoring the various other specifications and it is hoped that at a meeting to be held during this Annual Convention, mutual agreement can be reached on a standard method of tests for welds which can then be submitted to the Board of Directors for ratification.

*Committee on Large Welded Pipe for Hydraulic Purposes.*—Your Committee has prepared a tentative draft of a code which comprises the general ground covered by the existing codes for unfired pressure vessels with the exception of rules for special fittings such as stiffening rings, supports, reinforcings around openings, Y's, Tees and such. These are left purposely in order to develop first the main body of the code, leaving treatment of specials, for a second stage. The first drafts have been submitted to members of the committee and to two or three manufacturers for their comments; as soon as all comments, criticisms and suggestions are received, they will be codified and distributed again to members for their study. Following this, a revised draft will be prepared and distributed in printed form over a still larger field, including all principal manufacturers and users of such pipe. After this distribution, it is expected a final draft can be prepared for provisional adoption.

*Conference Committee with A. S. M. E. Boiler Code Committee.*—Your conference committee has had a year of successful cooperation with the Boiler Code Committee and can report satisfactory results. The consultation during the past year has been mostly on minor details of revisions of the Code which the Boiler Code Committee has made to bring the Code Rules up to date and keep in step with progress in the welding art. This cooperation appears to be essential to the proper development of fusion welding in the boiler and pressure vessel industry.

Your Conference Committee has been enlarged by addition of representatives from the Bureau of Engineering, the Bureau of Construction and Repair and the Bureau of Ordnance of the U. S. Navy Department.

*Development of Inspection Method Used in Manufacture of U-69 and U-70 Pressure Vessels.*—Your Committee has been concerned with the preparation of a specification covering the application of the trepanned plug method, originally suggested by Mr. E. R. Fish of the Hartford Steam Boiler Insurance and Inspection Company. Tentative report was submitted to the Committee for comment and criticism. As a result of replies received, the proposed specification was revised on a compromise basis and the revised draft will be acted on at a meeting of the Committee to be held during this Annual Convention.

*Welding Research Activities.*—The end of the fiscal year 1936–37 finds the Welding Research Committee well established. The work has been divided into three divisions, namely, Fundamental Research, Industrial Research and Literature. Each division has to its credit many important accomplishments. A total of 32 reports comprising 368 printed pages, were published during the year. The reports dealing with critical digests of the literature are first mimeographed and distributed to experts all over the world for criticism before publication as supplements to "THE WELDING JOURNAL." The Welding Research Committee and its three divisions have drawn into the work the leading welding research experts in this country.

Through a unique cooperative arrangement a service has been established whereby translations of the most important articles on welding published in the various technical periodicals of the world are made available to research workers and others interested. The important welding problems needing solution have been compiled and are available to those interested.

*Welding Handbook.*—Your Committee at the last Annual Meeting was instructed to proceed diligently with the preparation of the Welding Handbook. This they have done. It was quite a task to initiate activities and revive enthusiasm that had been dormant for nearly a year. However, your Committee reports with much pleasure that approximately 60% of the chapters scheduled for the book are now in the hands of the printer and have been reviewed by five or more experts. A deadline of October 1, 1937, set for the receipt of additional material which is being reviewed and soon will go to the printer. Your committee and all of us regret that we can show you in the Society Booth at the Exposition only a complete cover and dummy.

Expectations are that the Welding Handbook will be available for distribution about the first of next year. Your committee is doing a thorough job. Both they and the authors deserve our cooperation and patience in the completion of this first world's authoritative welding handbook.

*Education.*—Your Committee has prepared an outline of a recommended lecture course for the benefit of the Sections of the Society. The Committee recommends first, a series of four lectures dealing with the fundamentals of welding, and the effect of welding on the more common base materials; and second, a series on the subject of greatest local interest to the respective sections. Your Committee has offered to further assist the Sections by furnishing lecture notes for any lecturer on the course.

Your Committee through the Society office is conducting an extensive survey of speakers and movies available for lectures and meetings and of all welding educational facilities of the country, technical schools, trade schools, welding clinics and conferences and industrial schools whether for employees of one company or by welding equipment manufacturers and others for training of employees of other companies and embryo welders.

Making helpful data, experience, model layouts and shop details available is a most valuable service the Society can render in perfecting the knowledge for the welders of tomorrow and preparing executives for their responsibilities in supervising welding and in the maximum realization by American Industry of the benefits of of Welding.

A round table for all members of the Society interested in Welding education and instruction has been set for Wednesday afternoon of this 18th Annual Meeting.

*By-Law Amendments.*—Your Committee on Revision of By-Laws has handled simply routine matters. These consisted of the revision, correction and approval of the By-Laws of each new section as it was formed, to be sure that they conflicted in no way with the by-laws of the parent organization.

In addition to this, the Committee made suggestions to your Board of Directors for revision of by-laws of the National Society to bring them in accord with the present set-up of the Society, with its Managing Director, its greatly increased number of sections and with the substitution of the Engineering Foundation—Welding Research Committee for the former American Bureau of Welding.

The revision of the By-Laws recommended by your committee was subsequently approved by the Board of Directors and is now being voted on by the membership by letter ballot, and the proposed revision of the Constitution will be acted upon by the membership at the meeting this morning in Atlantic City.

*Welding Journal.*—For the first nine months of this year, there has been published in the Journal a total of 740 pages, compared with 428 pages last year.

The arrangement with the Engineering Foundation for the publication of the

research reports as a supplement to the Society Journal continues, and it is one of the Journal's strongest features. Several new departments have been inaugurated. The most notable special feature being the two-page pictorial review each month depicting progress in the various fields of application of welding.

In line with the Journal's improvements and because every issue has valuable research material of tremendous value to various people the one issue-nonmember buyer for some specific item or supplement costing several hundreds to present—only pays $1 a copy.

If he is eligible to membership any one can join the Society in the class to which he is eligible and receive every issue of the Journal at no extra cost other than his dues.

Probably the best barometer of the acceptance of the improved Journal that Editor Spraragen is putting out—is that we find 24 more advertisers in this October 1937 Convention number than were in his 1936 October issue. This October Journal has 172 pages of intrinsic value to the welding folks.

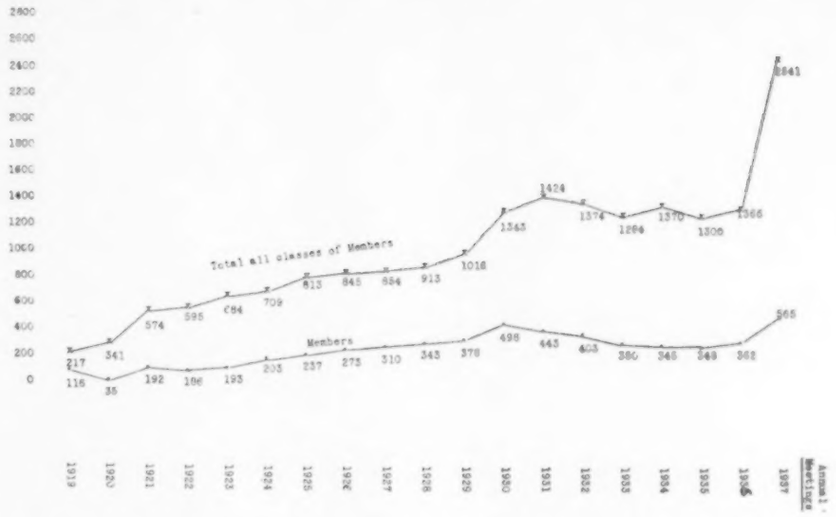
Editor Spraragen justly deserves our heartiest commendation for his tireless work and earning the recognition for the Journal of the Society as the World's leading Technical magazine on Welding. With the increased advertising support it merits he has in mind still more improvements to hold this premier position.

Your present officers because of changes of dates of Annual Meeting and publication of Yearbook—will never appear in one. We remedied that somewhat by publishing their names and committees all in the July issue. Your 1937 Yearbook will be the December number of THE WELDING JOURNAL. Be sure the office has your correct name and address and title and connection for this "Who's Who in Welding." Urge your friends who should be in the Society to join up before November 10th and be in the record of 1937—the greatest year Welding has yet known. Too many are still "off the record." Do your part at least ask them—then they can't say "Nobody ever asked me to join A. W. S."

*Public Relations.*—Nor have we neglected the possibilities for the promotion of the art and science of Welding. The N. Y. Code action and many other special write-ups by members and their publicity men or sales promotion departments have greatly aided the cause and placed the Society to the foreground. Your Committee met yesterday. They are developing an extensive welding market survey and the coordination of the facts on that market as distributed by various publications and others.

This Annual Convention was carefully publicized by this committee in an intelligent manner assisted by the publications and organizations in the field and by Mr. Grady, Public Relations Counsel of the Engineering Foundation. Like all other activities the Society profits from the invaluable voluntary contribution of personal effort, energy and work of our committees.

*Annual Meeting and Exposition.*—The




Convention this year promises to be one of the most outstanding in the history of the Society. Thirty-one papers dealing with research—fundamental and industrial, fabrication, alloy steels, railroad and shipbuilding, will be presented in the technical sessions. Most of these papers have been published in the October —Convention number of the Journal. The others, and discussions taking place at this meeting, will be published in later issues of the Journal.

The number of exhibitors of welding equipment and welded products surpasses that of other years. Your Manufacturers' Committee has brought about this increase by contacting the manufacturers of welded products as well as the welding equipment manufacturers.

Your Society, through its local sections on the west coast, has been invited to participate in the 1938 West Coast National Metal Exposition in a manner similar to the exposition in the east.

*Lincoln Gold Medal.*—In December of the past year, your Board of Directors gratefully accepted the generous offer of Mr. J. F. Lincoln, president of the Lincoln Electric Company to donate a medal to be given through the AMERICAN WELDING SOCIETY. The 1937 award is to be made for the paper published in the AMERICAN WELDING SOCIETY JOURNAL that has contributed most to the development and advancement of welding in the judgment of a committee appointed by your Society. Papers to be presented at this Annual Meeting, received prior to September 15, 1937, have been considered. The Committee consisting of Colonel Jenks, U. S. A., Washington, D. C., Mr. K. V. King, Chief Engineer, Standard Oil Company of California, Mr. F. E. Rogers, Editor and Engineer, Air Reduction Sales Company, will render its decision at this session and present the first award of this new medal.

*Membership.*—In October 1936 we had 1366 members. During the year Chairman Davis and his committee added 1366 more or doubled the number. However on October 1, 1937 when the records were audited we found that 191 members had been lost by the wayside so we are still 7% shy of the double number of 2732—having only 2541 members on the stencils October 1st. "That's all there is to report," said Mr. Davis—but I think there is a lot more to it than that. Under his leadership with a fine personnel the Membership Committee have been working since before my term in office and have more than doubled the net number of members of June 1936, when they started.

They certainly have more than doubled the Sustaining members—now 76—at $100 per year and the welding operating members now over 600 at $5 a year—the highest and lowest classes of membership. They have nearly done so for regular members. We had 317 last year—now well over 560 members at $15 per year. They almost did so for Associate members as against 734 last year we now have 1250 at $10 per year.

This is a real achievement and I believe the Society is headed for another double or 5000 members by October 1939 because with present new Sections forming 3000 are practically assured by January 1st. Another test of our sound membership position is we had only 163 delinquents, on October 1 over two months in arrears. A year ago because of the fine work of the Membership Committee the Society was able to stand dropping over 600 depression delinquents with very little loss in stride as we quickly recovered the drop off. The membership chart we have inserted shows a steady growth which has been secured this past year because we had to beat that loss—and the drive of Charlie Davis carried us up above any former growth and yet we have tried to build soundly. Memberships that will stick because of their vital need for the services of the Society—who join voluntarily—not high pressured just to swell the ranks. We are concentrating on developing that first $15 member in important welding shops—a Sustaining Member in the large ones.

*New Sections.*—This growth in members was possible too because of many new Sections which have been or are being formed. In many districts there were none or only a few members to start with and the required 25 or more to establish a section have been obtained. Kansas

City heading the list with 96 represented here today by three or more men.

South Texas or Houston is our second strongest baby Section with 61 members and growing every day. Closely on its heels is that lusty St. Louis crowd which after nine years of independence came into the fold last June. I prophesy they soon will be giving the others a run for first place. Youngstown, the Northwest, Birmingham and on down the line of 11 new Sections chartered—north, south, east, west—and even across the water to Honolulu. With the latest new one from the seat of our government in Washington, D. C. established this month—to the first of the 1937 additions, the chapter at Fort Peck, Montana, the Society has grown to 23 active and one inactive chartered Sections with some 18 others in various stages of formation.

Educational meetings have been held in several cities where Sections are possibly not practicable. Many of our preliminary meetings in these new areas were held under joint auspices of local engineers' clubs, chapters of other societies and with the help of local chapters of our co-sponsor of the great Metal Exposition, the American Society for Metals.

So as we gather today the score stands 24 Sections of the Society—one of which is still inactive as against 14 with two inactive a year ago. My own Section, Cleveland, which a year ago stood second in members, will have to get busy this winter to make up for the transfers to other Ohio sections which were established. It now stands fifth.

*Representatives on Other Societies.*—During the past year, the Society through its representatives, has continued to participate in the activities of the following organizations:

Association of American Railroads—Committee on Tank Cars;
American Standards Association—Committee on Building Code Requirements for Iron and Steel;
Electrical Definitions;
Electrical Welding Apparatus;
Committee on Standardization of Graphical Symbols and Abbreviations for Use on Drawings;
Ventilation Code;
Committee on Standards for Drawings and Drafting Room Practice, Sub-Committee No. 6 on Graphical Symbols on Drawings;
Committee on Code for Protection of Heads and Eyes of Industrial Workers;
American Society Testing Materials Sub-Committee B-5 on Copper Alloys;
Committee A-1 Sub-Committee XXI, Steel for Welding;
Committee on Pressure Piping;
American Transit Association—Way Structure Sub-Committee No. 6 on Welding;
American Society for Metals—Recommended Practice Committee;
Merchants Association Advisory Committee on Revision of New York City Building Code;
Executive Board of National Board of Boiler and Pressure Vessel Inspectors;
National Research Council—Engineering Division.

Space does not permit giving a detailed account of these activities although report is available in the Society files to any one interested. Our representatives have served diligently and will whenever called upon see that welding is properly covered in all standards in accordance with the codes and standards of the Society.

*Finances.*—The Auditor's Statement and complete record are in the hands of the Finance Committee under the chairmanship of our Treasurer, Mr. C. A. McCune, and they are rendering a complete report to the Board of Directors tonight. Any member can obtain from them any facts that they care to have, and the final statements of course, will appear in the Yearbook of the Society which is published early in December as the December WELDING JOURNAL.

The net worth of the Society according to the Auditor's report stood on September 30, 1937 as

| | | |
|---|---|---|
| Total Current Assets | $4,885.06 | |
| Fixed Assets | 3,760.93 | |
| Total Assets | | $8,645.99 |
| Total Liabilities | | 2,883.21 |
| Net Worth | | $5,762.78 |

The Society has been operating on a balanced Budget as set down by the Board of Directors.

*Management Committee.*—As a part of the financing we should mention the work of this committee. At the Annual Convention in Cleveland in 1936, the report of the Ways and Means Committee was submitted to and accepted by the Board of Directors. Without question, the acceptance of this report will prove to be one of the most important steps the Society has ever taken to strengthen its position as a national technical society for the promotion of the science and art of welding.

To carry out the provisions of this report, there was appointed by the President a committee known as "The Management Committee." During the past year the following results have been obtained:

The employment of Mr. Warner S. Hays as Managing Director of the Society, and the chief salaried executive officer; the enlarging of service at New York office made possible with the leasing of much needed, long urged, larger office space; and the employment of additional clerical help to take care of the increased activities of the Society.

In order to carry out the above program, the financial underwriting support of interested industry was sought and obtained to the extent of $24,000 per year for three year program. It is expected that increased membership and increased advertising in the Journal will enable the Society to carry on its increased activities without outside assistance by the year 1940.

*Conclusion.*—Your president appreciates very keenly the splendid cooperation which has been given him by the employees of the Society and the general membership. Without the willing and effective cooperation of our members little progress could have been made. While the growth in sections and membership and the splendid technical work of the many committees have resulted in gratifying progress, the results which will be obtained in the coming year will without question far surpass anything we have had heretofore.

I have thoroughly enjoyed my year as President of your Society and very reluctantly hand over the reins to my successor, but I do so with absolute confidence in his ability as a leader who will obtain excellent results during his term of office. In resuming my place as simply a member of the Society, I do so with the hope that I shall be called upon to assist in the future work, whenever my services can be of value to the Society.

## "The Electric Arc as a Welding Tool"

Mr. K. L. Hansen, prominent member of the American Institute of Electrical Engineers and the AMERICAN WELDING SOCIETY, addressed the Baltimore section of A. I. E. E. on Wednesday, October 20th, in the Maryland Hall located on the campus of Johns Hopkin's University.

Speaking on "The Electric Arc as a Welding Tool," Mr. Hansen discussed the characteristics of welding generators required to meet the exacting conditions of the welding circuit, the effect of current fluctuations in the arc circuit, the effect of shielding the arc for typical arc welding application, and illustrated a number of points by the use of lantern slides.

This was also the subject of Mr. Hansen's talk at the Hotel Raleigh on Thursday evening, October 21st, in Washington, when he spoke before a gathering of the Washington section of the American Institute of Electrical Engineers.

## Obituary

D. D. WACHTER, Sales Manager of Arcos Corporation, died very suddenly from gasoline burns on October 5th at Taylor, Pennsylvania. All of Mr. Wachter's personal and business friends are saddened by this loss.

## Catalogue

The Champion Rivet Company, of Cleveland, Ohio, has issued a new catalog describing its complete line of Welding Electrodes. In its 56 pages are included: welding procedures of pressure vessels and low-alloy steels, physical and metallurgical facts on the art and application of the shielded-arc process together with a handy reference section of useful tables and data.

## Vegetable Welding—Outstanding Achievement of the Century*

By DR. S. I. McPHERSON

*The discoverer of this epoch-making welding process, and author of this astonishing paper,* is famed in scientific circles as a specialist in dendritic structures. Born in California of Scotch parentage, he recently returned to the mother country to receive the gold medal of the Inverness Royal Thermal Society. He is a fellow of the San Diego Critical Circle, past-president of California Creators, honorary member of the Inner Guild, author of such brilliant scientific papers as "Little Journeys Through Molecules," and "After Matter, What?"*

Dr. McPherson Listens to the Sound of the Sea at Atlantic City

Ever since the diehards of his day forced Galileo to retract his statement that the earth revolves about the sun, every radically new departure in science and invention has been greeted with derision. I need mention only the steamship, the automobile and flying machine. This opposition, strange to say, did not arise from the ignorant only. On the contrary, sailors derided the steamship, carriage builders, the automobile and kite flyers, the airplane.

Knowing this history, I come here tonight with much trepidation, in spite of the fact that you are welding experts—perhaps even because of that very fact. For the discovery I shall describe here for the first time tonight has two characteristics that place it in the danger class as far as my personal reputation and safety are concerned. First, it lies in the field of fusion welding. Second, it is extremely radical in character. I refer to the fusion welding of various organic materials of oriented cellular structure.

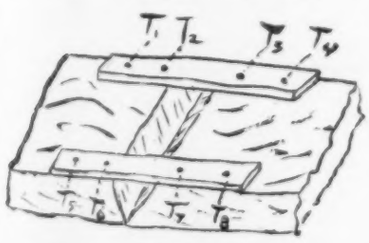



Fig. 1—Planks Are Lined Up by Tack Welding, Using the Tacks $T_1$, $T_2$, $T_3$, $T_4$, $T_5$, $T_6$, $T_7$ and $T_8$

* Presented at the Annual Dinner, A. W. S., Atlantic City, Oct. 21, 1937.

I shall go into this in detail a little later. For the moment, just remember the uses of sealing wax and grant that some applications, at least, are possible in this field. The real extent of progress made, as I shall reveal it a little later in the evening, will, I am sure, be nothing short of astounding.

I should explain that the experiments of which we now have the superb results have been carried out over the past twenty years in my laboratory at San Diego. Complete secrecy has been maintained; no inkling of my discoveries has appeared in the popular or technical press. And, by the way, I trust there are no reporters present tonight. If there are, I earnestly request that they treat all they hear as confidential. As a matter of fact, the chairman of your program committee is quite a salesman. I now feel that I yielded too easily to his powers of persuasion. But a bargain's a bargain.

Before getting to the practical developments, it will be worth while to review, very superficially, the theory of the process as it was gradually developed by logic and experiment and, to some extent, by lucky accident.

Sealing wax, as you may have guessed, was the starting point. Two rods of sealing wax can easily be joined, using a third rod as filler material and a candle, or other low temperature flame, as the heat source. By interspersing the wax with fine metallic powder it can be rendered sufficiently conductive for welding by the arc process, using fairly high voltage and current-limiting regulators.

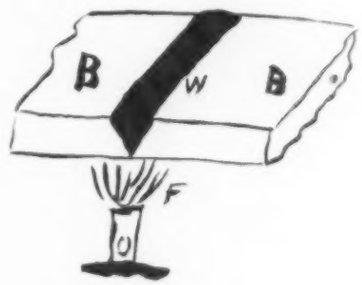
The welding of sealing wax is easy, simply and purely because its melting point is below its temperature of chemical disintegration. Rubber occupies an intermediate position. Vulcanizing is a species of welding, combined with some degree of chemical change. But these are very limited applications. There is a great group of important commercial organic substances whose melting points are far above their temperatures of destructive distillation. Examples are coal, wood, meat, paper, cardboard, etc., the most important, from the commercial angle, being wood. Obviously the fusion welding of such materials involves technical difficulties of the first magnitude. In work of this kind cut and try and rule of thumb are useless. Nothing but fundamental research will give the answer, if there is any.

At the very start it was evident that one of two things, or both, must be accomplished. The melting point must be depressed, the distillation temperature must be raised, or both. Evaporation of water would ordinarily constitute a third obstacle, but this was avoided by using kiln-dried wood in all of the experiments.

In the early days of my work I spent much time reviewing the researches of Prof. B. S. Holtzkopf of Berlin. Prof. Holtzkopf found that if the fibers of wood were first saturated with certain detergents, such as metamorphol, or other meta compounds of the gripper-molecule type, the grippers would hold the volatile constituents tightly until the explosion pressure of the gripper was reached. The pressure to be resisted was, of course, a hyperbolic function of the absolute molecular temperature, while the resisting gripping action was a simple straight-line function of the beam strength of the ultramicroscopic cantilevers. Holtzkopf was forced to the conclusion, which my own experiments confirm, that the elevation of the destructive distillation temperature is expressed by the formula

$$T_e = M \times 0.0006^{2}/_{3} / \int_0^B T \times (T_a \times D_m \times F_d \times F_c)^{3}$$

where $M$ is percentage of metamorphol
$T_e$ is temperature elevation, deg. C.
$B$ is the bilateral width
$T$ the thickness
$T_a$ the ambient air temperature
$D_m$ the meridian diameter
$F_d$ the double-entry factor
$F_c$ the centralizing factor.



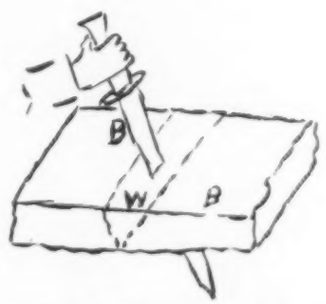




Fig. 2—Weld $W$ in Boards $B$ and $B$ Is Stress Relieved by Flame $F$ from Candle $C$

This is more simple than it seems at first blush, but further simplification was indicated by the remarkable work of Haykookoo of Tokio about 10 years later. He found that the temperature elevation produced when wood is saturated with metamorphol is merely the product of gripper arm, toggle effect and the percentage of detergent.

As men concerned with the practical applications of welding, you will probably not want to go deeper into this theory. I need merely say that this bottle contains a sample of a compounded detergent, or

Fig. 4—Impact Test: Candle Flame *C* Gently Releases Cord Passing Over Pulleys *P* and *P*, Holding Up Axe Head *A* by Handle *H* Pivoted in Standard *S*

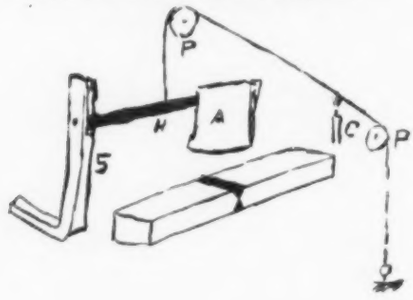



Fig. 5—Welding Dowel Pins: Fusing Current Is Passed Through Dowels *D* by Means of Bronze Pins *BP*

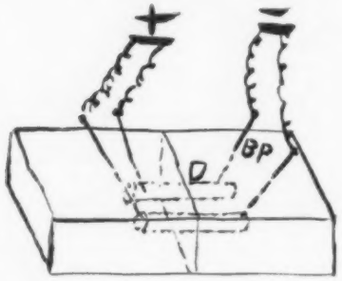
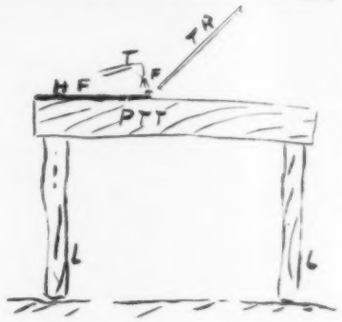



Fig. 6—Hard Surfacing: Pine Table Top, *PTT*, Supported on Legs *LL*, Is Provided with a Hard Finish *HF* Using Torch *T*, Flame *F* and Teakwood Welding Rod *TR*



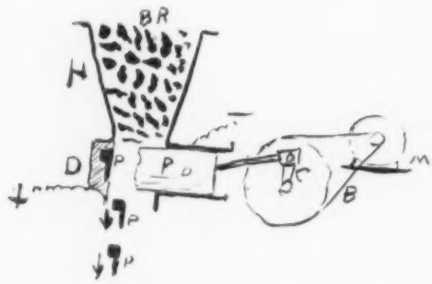




Fig. 7—Die Casting of Smoking Pipes: Motor *M*, Through Belt *B*, Turns Crank *C*, Working Plunger *P*. Halves of Forming Die Are on Head of Plunger *P* and Die Block *D*. Briar Roots Soaked in Metamorphol and Bronze Powder Are Fed from Hopper *H* Between Plunger and Stationary Die and, at the Same Time, Given a Shot of Electricity Which Fuses and Forms in a Single Operation. Finished Pipes Drop Out at *PR*

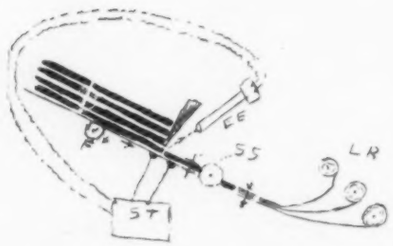



Fig. 8—Continuous Log-Weld Lumber Machine: Logs Accumulate on Inclined Chute and Are Forced Under Barrier by Feeder Roll *F*. As Contact Space Between Two Logs Passes Under Electric Eye *EE*, Shot Timer Passes a Measured Charge of Electricity Across the Log Gap, Fusing the Two Ends Together. Log Then Passes Through Squaring Saws *SS* and *SS*, Then Through Splitting Saws, from Which It Is Rolled Up as Continuous Lumber on the Log Rolls *LR*

Fig. 9—Production of Continuous Lumber from Sawdust: Hopper Contains Sawdust *SD*, Saturated with Bronze Powder and Metamorphol. This Passes Through a Series of Rolls, $S_1$, $S_2$, $S_3$ and $S_4$. Through Each Pair Electricity Is Passed, Fusing and Consolidating the Sawdust Until Finally a Board of the Proper Thickness Emerges from the Lower Pair of $S_4$. This Passes Under $R_1$, over $R_2$, under $R_3$, under $R_4$, past $R_5$ and Up to the Continuous Board Roll *BR*, Ready for Shipment to the Construction Job

metamorphol, which will enable any wood to be raised to 3700 F. without destructive distillation. When you remember that the melting point of white pine is only 2800 F. and even that of teakwood, most refactory wood, is only 3300 F. the real possibilities of wooden welding become evident in spite of the ridicule which so-called experts have heaped on the suggestion. It is obvious, also, that burning is impossible at any lower temperature, because burning must always be preceded by distillation.

My allotted time is slipping away and I must hop along to the practical applications of this principle.

In plain English, the primary practical problem is to weld two wooden boards together along their edges, or at their ends, using a filler road of wood or sawdust and the heat of an oxyacetylene flame or electric arc.

Rod material and the planks are first soaked overnight in a vat of metamorphol. Then ends or edges are scarfed (single or double 45 deg.) and welding is conducted exactly as with low-carbon steel.

Penetration is particularly important. To assure it, first fuse the root of the vee without filler rod. Then clean out with a sharp jacknife before starting to use the filler rod. The welding is continued to form a raised bead which is then planed and sanded down to the plank level in all cases, as the weld is invariably stronger than the parent wood, being amorphous and solid, free from cells, knots and air holes.

Your committee did not give me time enough to have my finished drawings sent on from San Diego. I have therefore been forced to make slides from hasty sketches. I hope, however, that these will be sufficiently clear to reveal the epoch-making nature of this development.

Slides, Please:

As practical welders, you will all understand the method of lining up the pieces to be welded by tacking (Fig. 1) using the tacks $T_1$, $T_2$, $T_3$, $T_4$, $T_5$, $T_6$, $T_7$ and $T_8$. Figure 2 shows the method of stress relieving and Fig. 3 of testing penetration. Another very important test, that for impact, is best accomplished with the apparatus shown in Fig. 4.

*Question:* "Dr. McPherson, why don't you stress relieve by steaming the wood as they do in bending ship frames?"

*McPherson:* "That's a very good suggestion. I shall try it out as soon as I get back to San Diego."

Figure 5 shows how dowel pins can be welded integral with planks.

*Question:* "How do you make the dowels sufficiently conductive for resistance welding?"

*McPherson:* "The dowels are not of ordinary construction, but pressure-mold welded of a mixture of sawdust and bronze powder, soaked in metamorphol.

Figure 6 shows the method of hard-surfacing a pine table top, using a teakwood rod soaked in metamorphol. The economy of this method of table construction will be apparent to all.

Figure 7, illustrating the mass production of smoking pipes, takes this wooden welding process into an entirely new field, that of die casting. The briar roots are soaked in metamorphol, and mixed with bronze powder, to render them conductive. A combination of high pressure in a die, with a shot of electricity, fuses and shapes the pipe, which drops out completely formed, as shown at *P.P.*

*Question:* "Does the metamorphol improve the taste of the pipe?"

*McPherson:* "I would not go so far as to say that there is an actual improvement. Certainly it would be impossible to make the average pipe taste or smell worse. Some chemists claim that the gripper molecules of the metamorphol seize on some of the tobacco molecules and grip some of the less volatile smells."

*Question:* "Dr. McPherson, was your pipe made by this process?"

*McPherson:* "I am very sorry to say it was not. I bought it right here in Atlantic City. I think it was at an auction on the boardwalk."

*Question:* "Thanks; now I understand."

It is a strange thing that builders and carpenters have been content for centuries to waste the ends of boards or sell them at a loss. With wooden welding, continuous lumber becomes an obvious possibility, which can be produced in various ways. One method is to weld the logs end to end, as shown in Fig. 8, using an electric eye and a shot timer, following by squaring saws and splitting saws which deliver endless lumber to the lumber rolls.

Continuous lumber can be produced from sawdust also, as shown in Fig. 9. The sawdust is soaked in metamorphol and bronze-powder and then passed through a series of gradually closing rolls through which electricity is passed to fuse the material. The finished board is delivered to the board roll *BR*.

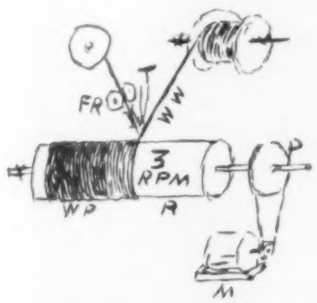



Fig. 10—Continuous Spiral Welded Wooden Pipe: Motor *M* Is Belted to Pulley *P*, Turning Rotor *R* at 3 R.P.M. Large Diameter Wooden Wire *WW* Is Fed from One Roll and Small Filler Wire from Another by the Feed Roll *FR*. The Wooden Wire *WW* Is Continuously Welded by Torch *T*, Forming a Single-Piece Welded Pipe

*Question:* "How does the logweld wood compare with the product of the sawdust reclaimer?"

*McPherson:* "The logweld wood has grain and the usual limitations that go with grain. Sawdust wood is definitely superior for all purposes except kindling. For kindling it is inferior because it can't be split and won't burn (because of the metamorphol)." I am sure you can all see the great advantage of the continuously spiral-welded pipe (Fig. 10) and the continuously spiral welded house (Fig. 11). The latter is an outstanding development. No engineer could fail to recognize its potentialities.

Fig. 11—Continuous House Welding: Vertical Motor *M*, Through Pulley *P*, Rotates House Frame (Which Must Be Circular) on Turntable. Torch *T* Rises Continually on the Screw Thread *S*. Continuous Lumber Is Fed from the Board Roll *BR* by Guide Pulley *GP*, and Is Welded Without Filler Rod

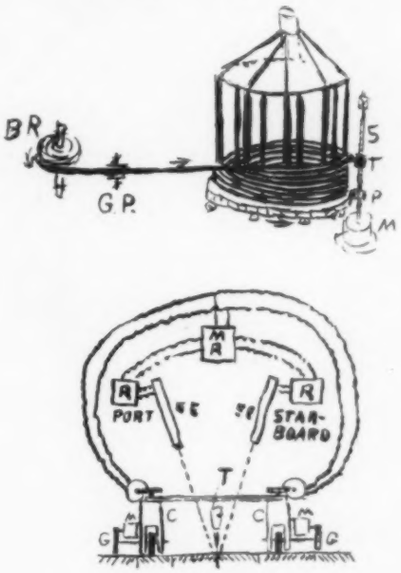



Fig. 12—Parquet Floor Welder (Patent Held by "Bugproof Floors, Inc.," 611 1/4 Tenth Ave., New York, N. Y.): Lines of Vision of Port and Star-Board Electric Eyes, *EE*, Straddle the Parquet-Floor Joint Which Is Painted with a Narrow Strip of White Paint. Carriage Is Propelled by Motors *M* and *M* Through Gears *G* and *G*. If Carriage Gets Off Line to Left or Right, the Corresponding Electric Eye, Through Relay *R* and Master Relay *MR*, Rotates Steering Motors on Worms to Guide Carriage to Right or Left and Get It Back on Line Again

*Question:* "Dr. McPherson, I know you will pardon me, but you don't seem to have made any provision for doors or windows. Is this a windowless building?"

*McPherson:* "That is a very good question. In fact, I feel it is a very intelligent question. The answer, of course, is that the doors and windows are cut out after the house is welded. A single cut around with one of those hand-operated buzz-saws produces the door and the door opening in a single operation. They always fit. All you have to do then is to attach the hinges and the door knob.

Of somewhat narrow application, but intensely ingenious, I feel, is the parquet-floor automatic welder, shown in Fig. 12. The patents are owned by "Bugproof Floors, Inc.," 611¼ Tenth Ave., New York. This will do all sorts of things that you can imagine, and some things that you would perhaps rather not.

*Question:* "What do you do when the machine following a single crack runs into a Y branch? How does the electric eye know which way to turn?

*McPherson:* "That is an extremely interesting question. I wish I had time to go into it, but I must leave soon to catch my train for San Diego. Thank you very much for your kind attention."

## Eighth Meeting for Thermal Studies in Paris Conference on Flames, December 16, 1937

The Center of Thermal Studies, headed by Charles Fabry, will hold its Eighth Meeting on Thursday, December 16, 1937 at the building of the Gas Welding Institute in Paris.

There will be an exposition of materials used in the production and utilization of flames as well as demonstrations of their most interesting applications. The Center of Thermal Studies and the Gas Welding Institute invites contributions in the form of papers and discussion by all interested in scientific, technical and industrial topics concerning flames.

PROGRAM

Part 1. Theory of the Flame. Chairman: Professor G. Ribaud.

(a) Theory of the Flame.

Chemical equilibrium in gaseous phases; constitution of flames; specific heat of gases at elevated temperatures; methods of calculating flame temperatures; flame velocities; temperature and constitution of the atomic hydrogen flame; theory of surfaces; combustion.

(b) Theory of Injectors and Burners.

Part 2. Transportation of Combustible Gases. Chairman: Mr. Bihoreau.

Transport of compressed gases and suitable tanks.

Transport of liquified gases and suitable tanks.

Valves and regulators.

Part 3. Utilization of Flames. Chairman: Mr. R. Granjon.

Oxygen, flames and combustion.

Properties and characteristics of welding and cutting flames.

Local heat treatment by flames; heating, quenching, case carburizing.

Application of flames in the laboratory and home; furnaces and burners.

Propane, butane and various hydrocarbon flames.

## New Book

INTRODUCTION TO THE STUDY OF WELDS by Professor E. Warnant and Dr. D. Rosenthal, Preface by Dr. A. Portevin. Bulletin No. 1 of the Laboratory of Materials Testing of the University of Brussels. Published by Dunod, Paris, 1937. 73 pages.

Part 1. Metallurgical Study of Welds—crystallization, recrystallization, segregation, air hardening, aging, occluded, dissolved and combined gases.

Part 2. Structural Welding—Static and fatigue loading. Hitherto unpublished results on fatigue tests of butt and fillet welds, and on the stress distribution in welded column connections with two arrangements of stiffening.

## Pittsburgh Woman's Hospital

The Pittsburgh City Council has recently authorized welding, both shop and field, of the new Women's Hospital, 14 stories, requiring a thousand tons of steel. The Council furthermore directed the superintendent of the City Bureau of Building Inspection to prepare an ordinance amending the building code to permit the substitution of welding for riveting and bolting. Members of the Pittsburgh Section of the Society are to be congratulated in bringing this about.

This building will be erected by the Stone & Webster Engineering Company.

By use of welding in place of rivets it is possible to decrease considerable the weight of a structure.

Members of Council stated that the new Women's Hospital will be the first structure in the city to be built by this process.

## The Ingot Phase of Steel Production

A comprehensive and authoritative book on ingot practice has been published by The Gathmann Engineering Company, Mr. Emit Gathmann, author. It covers all of the more important steps in production of steel from the finishing of the heat to the initial reduction of the ingot in the mill, and outlines the relationship between faulty practices in production and defects in the semi-finished and finished steel product.

# National Metal Congress and Exposition

At the National Metal Congress and Exposition, Atlantic City, Oct. 18–24, 1937, 11,000 engineers witnessed the latest developments in welding, the metals industry and heat treating. Unexcelled in arrangements, style and novelty the "Metal Show" was undoubtedly the outstanding industrial show of the season. Thinking it would be of interest to those who were unable to attend and serve as a record for those who did attend, we are including a brief description of the exhibits relating to welding and cutting.

The AMERICAN WELDING SOCIETY had an attractive booth in which it featured its numerous activities in the development of codes and standards. THE WELDING JOURNAL and its advertisers were prominently displayed as was, also, Section Activities, Research Work and Educational Courses. An attractive dummy of the forthcoming Welding Handbook aroused considerable favorable comment.

The American Welding Society Booth

The Governor Visits the Convention. Left to Right—Warner S. Hays, Charles A. McCune, Past-President A. E. Gibson, Governor Harold G. Hoffman and President P. G. Lang, Jr.

### Air Reduction Sales Company, New York, N. Y.

Exhibited (in operation) a representative group of its comprehensive line of flame-cutting machines. They cut in straight lines or in intricate contours, either vertical to the surface or at an angle. The work these machines will do in steel is comparable to that accomplished with a band saw in wood. They will follow a predetermined path with accuracy, making a kerf in the lesser thicknesses scarcely wider than a saw blade, and with a finish that is suitable for many purposes without machining.

Types ranged from the torch mounted on a motor-driven carriage and guided by hand to the templet-guided machine which cuts, without change of original set-up, many duplicates of the same design, using multiple torches centrally controlled from the operator's station.

In addition to this representative demonstration in mechanical gas cutting, flame hardening with the oxyacetylene torch as well as the new multiple welding of pipe was demonstrated. Hardfacing with Stoody products, Aircobrazing with Walseal Fittings and the use of the new low temperature brazing alloy with Sil-Fos was also demonstrated.

### Aluminum Company of America, Pittsburgh

One of the interesting exhibits in this very attractive booth was an all-welded aluminum beer barrel. Imagine the surprise of many of the visitors who were able to pick up the barrel with one finger.

### The American Brass Company, Waterbury

The American Brass Company Exhibit included special Anaconda engineering alloys as well as condenser tubes.

Among the alloys exhibited were Everdur, the high strength, weldable, structural metal; Beryllium Copper, the new heat treatable copper base alloy with exceptionally high physical values; Ambraloy; Tobin Bronze; and various Phosphor Bronze alloys. There were special displays of Everdur in the form of electrical conduit, welded pressure vessels, bolts, nuts, screws and other parts.

The condenser tube section included a prominent display of Super-Nickel tubes made by the extruded, rolled and drawn method in addition to the other standard Anaconda Condenser tubes.

Another section showed Anaconda Copper and Bronze welding rods and broken metal parts repaired by bronze welding.

A general exhibit of Anaconda sheet, wire, rod and tubes in various alloys completed the arrangement.

### American Coach and Body Company, Cleveland

Exhibited (in operation) their portable, flexible and adaptable spot welder of 75 kva. capacity. With this welder it is possible to make welds in the most out of way places, with one electrode grounded six feet from the place where the weld is being made.

### American Gas Association, New York

Exhibited among other things, gas cutting and brazing.

### American Steel and Wire Company, Cleveland

(See United States Steel Corp. Subsidiaries).

### Ampco Metal, Inc., Milwaukee

Exhibited welding jaws of this extremely wear-resistant alloy.

### Arcos Corporation, Philadelphia

Exhibited (in operation): Welded stainless and welded nonferrous products fabricated with Arcos special electrodes. They also operate a test showing corrosion resistance of 19/9 chrome-nickel weld metal.

### Automatic Gasflux, Inc., Cleveland

Exhibited (in operation) a demonstration of bronze welding with new type of flux injected into the gas stream. This is the new process recently developed and was shown at the show for the first time. All that is required is a portable fluxer, with cylinder, acetylene and oxygen. Also a demonstration of Ferrolene gas cutting with a machine torch was shown.

### The Babcock & Wilcox Co., New York

The Babcock & Wilcox Company exhibited samples of B & W 80 Firebrick, B & W Junior Firebrick and B & W Insulating Firebrick; also B & W Mortars and Plastics.

Of special interest to welding engineers were illustrations of notable installations such as: Stress-relieving furnace for the world's largest welded pipe, at Boulder Dam; Specially designed furnace for stress relieving the world's largest telescope frame; The first stress-relieving furnace built with Insulating Firebrick, at Babcock & Wilcox plant, Barberton, Ohio; Heavy billet forge furnace, lined with B & W Insulating Firebrick; and Stress-relieving furnaces for welded pressure vessels.

A Birdseye View of the Exposition

**The Bastian-Blessing Co., Chicago**

A special booth dramatized the complete line of Rego apparatus. A demonstration of production gas welding was conducted throughout the period of the exhibit. Visitors were invited to participate in prizes given away for each the closest estimate of the number of parts welded daily in the Rego booth.

The company displayed for the first time in this booth a brand new venture in two-stage regulation. Rego new two-stage regulators are known as the No. 2060 series and have never before been announced in any advertisement or displayed at any exhibit.

Some of the outstanding features in the new regulators include complete range sensitivity in adjustment, triple filtering cartridge type filter, an unusually large second stage diaphram and a remarkable capacity for maintaining constant volume and pressure flow of gas regardless of the drop in tank pressure.

**Bethlehem Steel Co., Bethlehem, Pa.**

Exhibited (in operation): talking towers with physical property charts, fractures and photomicrographs will describe and show the effect of heat treatment on carbon, manganese, nickel, nickel-chrome, molybdenum and spring steels.

**Bonney Forge & Tool Works, Allentown, Pa.**

Exhibited: Bonney WeldOlets and ThredOlets. These individual stock welding fittings are designed to make branch pipe connections such as tees, crosses, side-outlets, etc., by welding.

A branch connection is made by welding a WeldOlet or ThredOlet to the main pipe, using an ordinary vee or fusion weld. The button is removed as desired, either before or after the fitting is attached to the main pipe. The junction is completed by welding the branch pipe to the outlet of the WeldOlet, or in the event that a ThredOlet is used the branch is simply screwed into place.

**Carboloy Company, Inc., Detroit, Mich.**

Gave an hourly demonstration of the torch brazing of Carboloy tools.

**Carnegie-Illinois Steel Corp., Pittsburgh**

(See United States Steel Corp. Subsidiaries)

**Eisler Engineering Co., Newark, N. J.**

Exhibited (in operation): Electric spot welders; electric butt welders; A.C. transformer type arc welders; and automatic timers and contactors.

**Electric Arc Cutting & Welding Co., Newark, N. J.**

Exhibited: Dualarc 400 ampere motor generator and gasoline driven welding outfits. Compensating and Universal extruded rods, and a complete line of arc welding rods.

The original Alternarc 500 ampere transformer type and the latest development in alternating current arc welding, was exhibited for the first time.

Also latest development for control, the shunt inductor and idling device for gas engine operation.

**Fabricating Progress**

See Industrial Publishing Company

**Ferrolene Gases, Inc.**

See Automatic Gasflux, Inc.

**General Electric Co., Schenectady, N. Y.**

Demonstrated the latest types of arc-welding apparatus, including the new G-E Mutator (D.C.) arc welder for use with light-gage metals; and new single-operator (D.C.) sets, including both motor-generator combinations and gasoline-engine-driven equipments. A complete line of G-E arc-welding accessories was also on display.

Modern industrial X-ray equipment was shown by the G. E. X-Ray Corporation.

**Handy & Harman, New York**

Two general purposes were put in effect in this company's booth in Atlantic City.

The first was a live exhibit or demonstration of all kinds of Low-Temperature Brazing by the Oxyacetylene Torch. Different kinds of metals, both ferrous and non-ferrous were joined and different types of joints were made.

The advantages of using this Handy Flux were also shown.

The second part of this demonstration was made up of a large number of samples of work from various manufacturers who use this company's products.

The Company demonstrated also metal joining by Electrical Resistance Methods.

**Harnischfeger Corp., Milwaukee**

Exhibited (in operation): P & H Hansen Smootharc welders using Smootharc welding electrodes; Introduction of the new P & H electric hoist with variable speed push button control—one ton capacity.

There was a display of the Smootharc electrodes showing their physical characteristics.

**Haynes Stellite Co., New York**

Exhibited: Haynes Stellite cutting tools for machining steel, semi-steel, cast iron and other metals; special Haynes Stellite castings; Haynes Stellited wearing parts; and Hastelloy corrosion-resistant alloys.

**Hobart Brothers Company, Troy, Ohio**

Exhibited (in operation): A full line of Hobart Simplified Arc Welders, including models for welding light gage sheet metal as well as for heavier work. The new Hobart magnetic type motor horsepower control was demonstrated in connection with electric motor driven models. Complete gasoline engine driven equipment and generators only, for belt or coupling operation. Provisions were made for demonstrating the equipment on various kinds of work and with various types of electrodes.

**Hollup Corp., Chicago**

Demonstrated different welding rods on two welding machines. One welder was suspended from the floor by a small weld specimen.

**Industrial Publishing Co., Cleveland**

Publishers of "Industry and Welding" and "Fabricating Progress." Exhibited descriptive material on the advances in the use of welding and its acceptance in fabricating metal.

**The International Nickel Co., Inc.**

Exhibited samples of the commercial applications of the nickel-alloy steels, nickel cast irons, Ni-Resist, Ni-Hard, nickel-bronze and other nickel-containing alloys.

**The Lincoln Electric Co., Cleveland**

Exhibited (in operation): Lincoln Shield Arc welders; Lincoln Shield Arc electrodes; Lincoln Shield Arc automatics; Lincoln Shield Arc supplies; and Lincoln Linc-Weld motors.

From the welding view-point this exhibit formed one of the most interesting at the Show. All kinds of welded samples having undergone various tests, such as, bending and distortion were exhibited.

**The Linde Air Products Co., New York**

Recent important developments of the oxyacetylene process and advances of oxyacetylene machine cutting were featured and several of the latest cutting machines were on view to show how the demands for various applications of flame cutting have been

answered with specially designed equipment. The new Oxweld Type CM-12 shape cutting machine, which covers a scope of work hitherto impossible with one machine, was in actual operation. Several new acetylene generators which have been introduced during the past year; a new line of Oxweld oxygen and acetylene regulators; and the latest in hand cutting and welding blowpipes. Live demonstrations portrayed some of the recent advancements in oxyacetylene welding equipment and procedures.

**Ludlum Steel Co., Watervliet, N. Y.**

Exhibited tool steel, stainless, stainless castings, nitralloy, FCC products, hard surfaced electrodes.

**Magnaflux Corp., New York**

The Magnaflux method of inspection, which is a non-destructive and rapid method for determining defects in steel and steel parts, was demonstrated on the latest development in Magnaflux units as employed in the railroad, automotive, aircraft, pressure vessels and general industrial fields.

Results of the method were exhibited on a variety of steel parts including the inspection of welds.

**Maurath, Inc., Cleveland**

On display was "Whitey" himself and a small scale model of "Whitey" and a very large scale model of the Maurath internationally known electrodes.

**The McKay Co., Pittsburgh**

The booth was used to announce the entry of The McKay Company into the arc welding electrode field.

**Metal & Thermit Corp., New York**

The Metal & Thermit Corporation had on display in its booth a complete line of Murex heavy coated electrodes for arc welding. The welding booth provided facilities for demonstrating several new electrodes recently added to the Murex line and gave an opportunity for persons, who wished to try out these new electrodes, to do so. Thermit welding, widely used in steel mill maintenance work and, at present, coming into somewhat extensive use for the welding of rails into long, continuous stretches on main line railroad track, was also exhibited, as were a number of the metals and alloys manufactured by the Thermit process.

**Morrison Engineering Co., Inc., Cleveland**

This Company exhibited a Morrison welding rod drying unit for baking flux coated welding rods. This unit is an oven made up of individual baking zones, all heated by a Morrison direct gas fired air heater. The heat is separately controlled in each zone to best suit the condition of the rods. The welding rods are conveyed through these zones on specially designed chain, remaining thereon until they emerge from the oven, completely and satisfactorily baked.

**National Carbide Corp., New York**

Exhibited National Carbide VG lights and National Carbide lanterns.

**National Cylinder Gas Co., Chicago**

Exhibited (in operation): A No. 646 National oxyacetylene shape cutting machine. This machine demonstrated shape cutting by following the lines of a drawing laid out on the template table, and by automatically following a template laid out on the template table.

Cuts made with this machine can be controlled so accurately that a very smooth cut held closely to dimensions is the result. On many operations the cut edge is so smooth, square and accurate that no machine shop work is necessary.

**Owen Electric Sales Co., Fayetteville, N. C.**

Exhibited their type "H-I" welder and Oscillograms made at the University of North Carolina, indicating representative pictures of the current and voltage waves produced by these two machines. The flat voltage waves on all the Oscillograms were particularly interesting as was, also, a strong direct current combination in several of the Oscillograms.

**Page Steel and Wire Division, American Chain & Cable Co., Inc., Monessen, Pa.**

Exhibited a complete line of welding wires.

**Horace T. Potts Co., Philadelphia**

Exhibited stainless and other steels, non-ferrous metals, alloy castings and special low alloy steels.

**The Pyle-National Co., Chicago**

Had a special display of electric receptacles for portable electric welders and of all types of plugs and receptacles used in electric welding and otherwise in plants using welding.

**Republic Steel Corporation, Cleveland, O.**

This Company unfolded the year's biggest story in new steel plant construction. It is the story of the 98-inch continuous hot and cold rolling strip mill, the world's largest, a mill that is designed to turn out over 2000 feet of strip steel per minute.

Another feature was the showing of the newest developments in the field of stainless steel. New products from the automotive, railroad, marine, textile, restaurant, hotel, hospital, chemical and other leading fields were presented.

One section of the booth was devoted to Republic Double Strength Steel, Republic's contribution to the high-tensile, low-alloy group. Large sections of railroad applications of the product were displayed.

**John A. Roebling's Sons Co., Trenton, N. J.**

Exhibited an entire line of wire products, including welding wire.

**Joseph T. Ryerson & Son, Inc., Chicago**

Exhibited large illuminated photographs describing their new and recently announced certified plan for handling alloy steels.

**Safety Gas Lighter Co., Lynn, Mass.**

Exhibited complete exhibit of ignition equipment for welders and for various gas installations.

**The A. O. Smith Corp, Milwaukee**

The A. O. Smith Corporation, Milwaukee, Wis. one of the pioneers in Arc Welding, showed in a series of pictures the application of the arc-welding process to some of their products. The pictures showed: The fabrication of heavy wall vessels, as used by the Oil and Petroleum Industry for cracking oil; the lining of vessels with sheets of corrosion resisting alloy, which greatly increases their life; the fabrication of multi-layer vessels, a construction which is of particular advantage for small diameter, heavy wall vessels; a view of the shop in which the large single piece, glass-lined vessels used mainly by breweries are made; the laying of Smith welded line pipe for oil or natural gas; the setting of Smith High Yield casing, a development of utmost importance in cases where the oil is found only at great depth, because this casing has a considerably higher resistance against collapsing; and the fabrication of welded parts for heavy machinery like presses, etc.

There was also shown and demonstrated an instrument found very useful in training, guiding and supervising hand-welders. It operates two flashlight bulbs mounted in the helmet of the operator on either side of the window. On the instrument itself is a dial calibrated in volts, and the desired welding voltage is set on this dial. There are also two more lights on the instrument working simultaneously with those in the helmet. If the welder is now holding an arc with the voltage set on the dial, both bulbs will be dark. With a deviation of one volt up or down, one or the other bulb begins to glow, its brilliancy increasing with the amount of deviation, a distinct improvement over similar attempts in earlier devices. The lights in the helmet therefore guide the welder to hold an arc with the correct voltage, while those on the device itself (which, of course, could be mounted somewhere else too) permit supervision by the foreman or superintendent.

**Stoody Co., Whittier, Calif.**

Exhibited a natural color motion picture film equipped for sound showing, among other things, hard-surfacing applications.

**The Taylor Hall Welding Corp. of Worcester, Mass.**

Demonstrated one of their new 17 kva. foot operated spot welding machines. New features on this welder are: Vertical movement of the upper horn and electrode, weight instead of spring pressure and the control switch located on the end of the foot treadle.

Four sample boards at the back of the booth displayed a large variety of spot- and butt-welded samples.

**Una Welding, Inc., Cleveland**

Exhibited (in operation): Una automatic head; Una shielded arc automatic process; and all types of Una shielded and unshielded rods.

**United States Steel Corp. Subsidiaries, Pittsburgh.**

Covering the entire stage of the Public Auditorium at Atlantic City, New Jersey, the exhibit of the United States Steel Corporation Subsidiaries at the 19th Annual National Metal Exposition, October 18th to 22nd, was one of the largest and most spectacular ever presented.

As a background for this theater, and towering 39 feet above it, a mural represented a huge, symbolic electric furnace pouring steel.

As a technical feature, presenting the outstanding research work of the United States Steel Corporation laboratory in Kearny, N. J., there were instructive exhibits on austenitic grain size and metallographic technique, including etching, a new polishing process and photomicrography. Another novelty was a table-high model of the American Bridge Company's modern Heroult Electric Furnace, equipped with the gantry type removable roof for bucket charging.

Other displays around the vast exhibit space, which embraced an area of 9396 square feet, were sample boards, on which are tubular products, wire products, strip steel and stainless strip steel, bars and rods, and an exhibit of various products made of U. S. S. Stainless Steel.

Several all-welded vessels which had been bulged outward by explosive shocks, demonstrated the strength of welds in the low-alloy steels manufactured by this company.

**Universal-Cyclops Steel Corp., Bridgeville, Pa.**

Exhibited tool steels, stainless steels and high-grade specialty steels.

**The Welding Engineer Publishing Co., Chicago**

Exhibited literature available to those interested in welding fabrication, maintenance and repair.

**Westinghouse Electric & Manufacturing Co., East Pittsburgh**

Exhibited (in operation): A complete line of A.C. or transformer welders; Automatic seam welder; M-g or flex-arc welders; Ignitron or seam welder controller; Electroplater using Westinghouse Rectox; Kovar; Konel glass blower to demonstrate Cupaloy die and hand press; Phos-copper (demonstration of brazing); and Hipernik.

**Wilson Welder and Metals Co., Inc., New York**

Exhibited complete line of Wilson electric arc welding machines—the 300-ampere motor generator set was demonstrated.

**The Youngstown Sheet and Tube Co., Youngstown, Ohio**

Exhibited a scale model of the 3-stand 4-high cold reduction mill, the original of which is in operation at the Campbell plant of this company.

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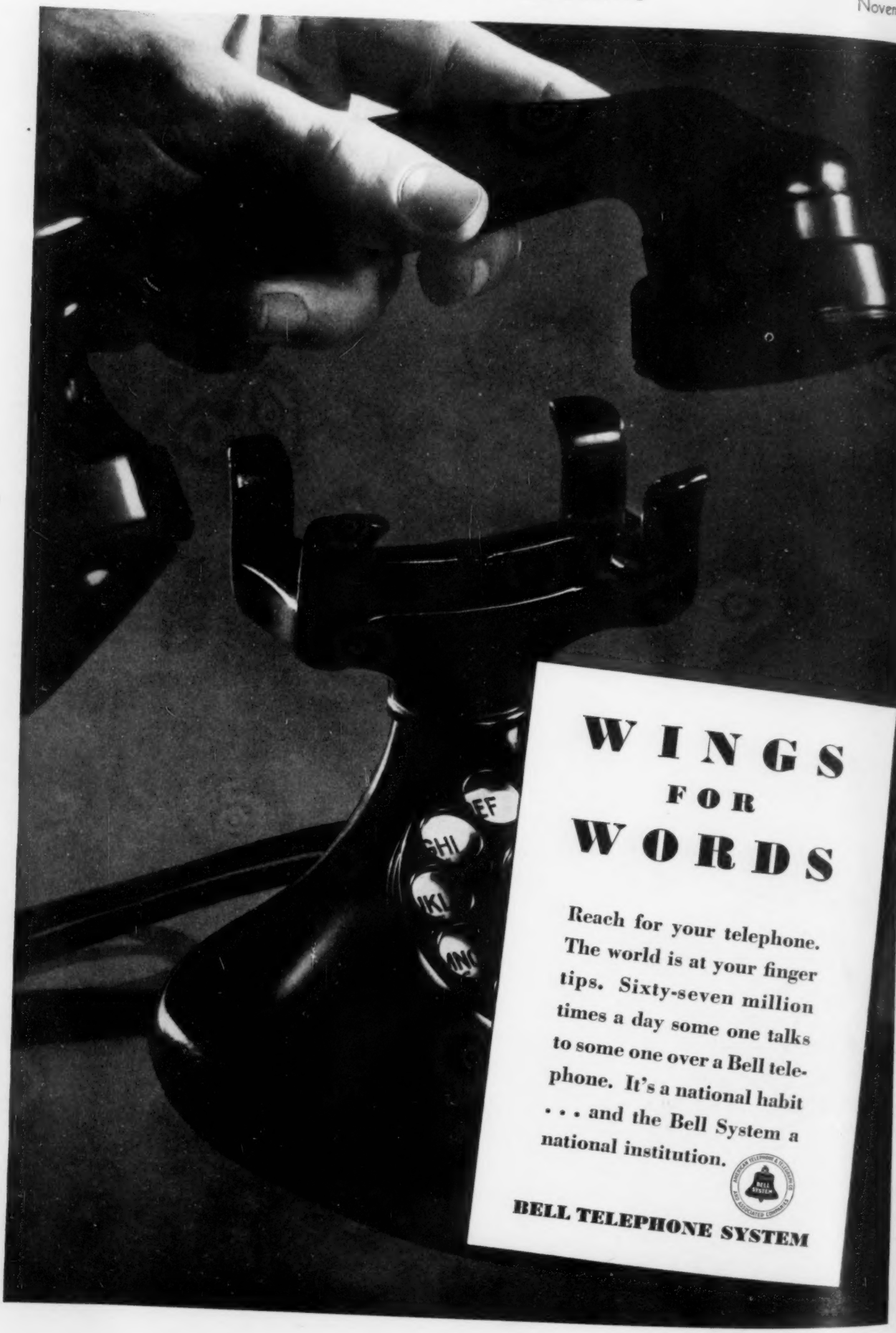
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